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NUCLEAR SCIENCE ABSTRACTS

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April 30, 1961

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TABLE OF CONTENTS

Volume 15, Number 8, April 30, 1961

Category	*Page*
GENERAL AND MISCELLANEOUS	1077
BIOLOGY AND MEDICINE	1080
General and Miscellaneous	1080
Biochemistry, Nutrition, and Toxicology	1088
Fallout and Ecology	1092
Radiation Effects on Living Tissues	1093
Radiation Sickness	1103
CHEMISTRY	1105
General and Miscellaneous	1105
Analytical Procedures	1114
General Inorganic and Physical Chemistry	1131
Radiation Chemistry and Radiochemistry	1136
Raw Materials and Feed Materials	1141
Separation Processes	1142
ENGINEERING AND EQUIPMENT	1148
General and Miscellaneous	1148
Heat Transfer and Fluid Flow	1150
Instrumentation	1156
Materials Testing	1177
GEOLOGY, MINERALOGY, AND METEOROLOGY	1177
HEALTH AND SAFETY	1185
INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS	1190
ISOTOPE SEPARATION	1194
MATHEMATICS AND COMPUTERS	1197
METALS, CERAMICS, AND OTHER MATERIALS	1199
General and Miscellaneous	1199
Corrosion	1202
Fabrication	1205
Properties and Structure	1208
Radiation Effects	1219
PHYSICS	1224
General and Miscellaneous	1224
Astrophysics and Cosmology	1236
Cosmic Radiation	1237
Criticality Studies	1240
Elementary Particles and Radiations	1241
Neutron Physics	1272
Nuclear Properties and Reactions	1275
Particle Accelerators	1299
Plasma Physics and Thermonuclear Processes	1303
Shielding	1319
Theoretical Physics	1322
REACTOR TECHNOLOGY	1325
General and Miscellaneous	1325
Power Reactors	1339
Research Reactors	1347
WASTE DISPOSAL AND PROCESSING	1350
CORPORATE AUTHOR INDEX	INDEX-1
PERSONAL AUTHOR INDEX	INDEX-9
REPORT NUMBER INDEX	INDEX-62
SUBJECT INDEX	INDEX-72

NUCLEAR SCIENCE ABSTRACTS

Volume 15, Number 8

April 30, 1961

GENERAL AND MISCELLANEOUS

8397 (AI-5257) THE AVAILABILITY OF ENERGY DURING THE NEXT CENTURY. R. A. Laubenstein and C. Starr (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). May 15, 1960. 12p.

Estimates of the resources of fossil fuels are compared with the predicted total demand for energy up to the year 2050. The cumulative total requirement for energy in the U.S.A. from 1960 to 2050 is predicted to be about 11 Q, where 1 Q = 10^{18} Btu. For the total world requirement, the prediction is about 34 Q. The U.S.A. has less than 5% of the land area of the world and about 30% of the world energy requirement. By considering the U.S.A. as an isolated country, a pessimistic projection of the adequacy of the energy resources is obtained. It is predicted on this basis that the 11 Q of energy will be obtained as follows: 1.8 Q from uranium used in converter reactors to generate electric energy; 1 Q from noncommercial sources of energy and from hydropower; 1.4 Q from oil and gas, including oil shale; and 6.8 Q from coal. It is also predicted that the utilization of fossil fuels in the quantities indicated will probably require an increase in price of about 50% over the present prices of these fuels. Sufficient uranium should be available during this same period with a fuel cycle cost increase of only about 25%. The contribution of breeder reactors toward enlargement of energy resources has not been included in the above predictions because breeder reactors are not now economically competitive with converter reactors, and it is not known at what date they will become competitive. There are sufficient resources of energy in the U.S.A., even without the use of breeder reactors, so that there will be no reason to become alarmed about a shortage of energy, at least during the next century. However, breeder reactors have the advantage of providing a stabilizing influence on the cost of energy at such time as they may become competitive. This stabilizing influence results from the large expansion of energy resources through the use of uranium or thorium in these reactors. This potential advantage of breeder reactors justifies a significant research and development program which has as its objective the development of breeder reactors that are economically competitive. Until that time, converter reactors will be able to provide appreciable quantities of energy to supplement fossil fuels. (auth)

8398 (ARL-TR-60-299) INVESTIGATION OF THE INTERACTION OF HIGH VELOCITY IONS WITH METALLIC SURFACES. Period covered: October 1959 through May 1960. Edward T. Pitkin (Astro. Marquardt Corp., Van Nuys, Calif.) Malcolm A. Macgregor, Vincent J. Salemme, and Richard Bierce (Applied Radiation Corp., Walnut Creek, Calif.). Oct. 1960. 56p. Contract AF33(616)-6844.

Measurements of sputtering yield rates and secondary electron emission on copper, molybdenum, and tungsten surfaces subjected to ion bombardment were made. Data were gathered as functions of ion energy (10 to 40 kev), mass and target incidence angle. It was found that sputtering rates are proportional to ion mass and inversely proportional to incidence angle and hardness of the target. Concurrent analytic research was the study of ion trajectories by use of a digital computer. A code was developed which was able to map out the electrostatic field with various electrode geometries and then determine the ion beam envelope with space charge effects included. (auth)

8399 (CF-59-5-126) PROBLEMS IN ACCOUNTABILITY MEASUREMENTS ASSOCIATED WITH THE INTERIM CHEMICAL PROCESSING PROGRAM. E. D. Arnold and A. T. Gresky (Oak Ridge National Lab., Tenn.). May 28, 1959. 25p.

Available knowledge of precision limits in S.S. accountability measurements and/or calculations by reactor and chemical processing groups is surveyed and summarized. Experience in comparisons of reactor (production and research) calculations vs. chemical plant accountability measurements is also reported. A general tentative conclusion is that available precisions (±0.54 to ±0.78%) in chemical plant measurements (bulk and analytical) for fissionable material accountability is superior to the variable precision (±1.0 to 11.0%) possible by calculations (nuclear and/or engineering) of power reactor systems; however, with operation and empirical experience (e.g., after two or three core loadings), it is believed that calculations for given reactors can attain acceptable precisions, e.g., less than ±1.0%. It may be proposed that fuel payments be made as follows: 90% of fuel value based on reactor calculations, an additional 5% based on dissolver analyses, and final settlement based on chemical plant material balance (product plus loss analyses). (auth)

8400 (MND-P-2356) PRELIMINARY OPERATIONAL SAFETY REPORT FOR THE TASK 5.6 THERMOELECTRIC GENERATOR. Daniel Knighton (Martin Co. Nuclear Div., Baltimore). May 1960. 54p. Contract AT(30-3)-217.

The operational hazards associated with the use of a plutonium-fueled thermoelectric generator in a terrestrial satellite are evaluated. It appears that the plutonium fuel can be consumed and dispersed at high altitude during reentry, following a successful mission. As an alternative, however, since the fuel (Pu^{238}) is an alpha emitter with a long half life, it appears that random intact reentry following a successful mission is feasible. As a precaution against aborted missions, the launch azimuth should be over water as much as possible to avoid impact or dispersion in areas of significant population density. It is recommended that the fuel and generators be transported by air carrier to preclude local restrictions of ground transport and to provide better statistical safety. The transport phase poses a very minor safety problem. (auth)

8401 (MND-P-2364) FINAL SAFETY ANALYSIS REPORT. SNAP III THERMOELECTRIC GENERATOR.

W. Hagis and George P. Dix (Martin Co. Nuclear Div., Baltimore). June 1960. 67p. Contract AT(30-3)-217.

The SNAP-III thermoelectric generator produces power from the decay heat of 2200 curies of Po^{210}. This generator is to be used as a source of auxiliary power in a terrestrial satellite. For purposes of analysis, the satellite system postulated is launched from the Pacific Missile Range into a 275-statute mile polar orbit with an orbital lifetime of about 1 year. Po^{210} is an alpha emitter having a half life of 138 days and alpha and gamma decay energies of 5.3 and 0.8 mev, respectively. It is a natural component of the earth's crust, as a member of the uranium disintegration series. Sampling of polonium in the biosphere was conducted specifically for this program to determine background radiation levels. Since the fuel is primarily an alpha emitter, there is no direct radiation problem. An analysis was performed to determine the ability of the fuel container to withstand the various thermal, mechanical, and chemical forces imposed upon the generator by vehicle failures. Where theoretical analysis was impossible and experimental evidence was desired, capsules and generators were tested under simulated missile-failure conditions. Thus, the safety limits of SNAP-III in a satellite application were defined. SNAP-III is designed to be aerothermodynamically consumed on reentry into the earth's atmosphere so that the polonium will be dispersed as aerosols in the upper stratosphere. Since heating rates will be lower for aborts occurring prior to orbiting, 65 abort cases have been considered to define the general consequences of vehicle failures. The spatial and temporal relations of vehicle aborts are summarized in cartographic and tabular form. (auth)

8402 (NP-9702) THE USE OF HIGH-ALTITUDE ROCKETS FOR SCIENTIFIC INVESTIGATIONS. An Annotated Bibliography. Mildred Benton, comp. (Naval Research Lab., Washington, D. C.). Oct. 1959. 122p.

A bibliography of references concerning the development of upper-atmosphere investigations by means of rockets is presented. The period covered is 1946 to 1959. 965 references. (J.R.D.)

8403 (NP-9705) ASTRONAUTICS INFORMATION. OPEN LITERATURE SURVEY VOL. II, NO. 11. (Entries 23,095-23,310). (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Nov. 1960. 76p. Contract NASw-6.

An open literature survey of 216 references on astronautics is presented. The material is arranged alphabetically according to subject. Author and subject indexes are included. (J.R.D.)

8404 (NP-9787) SECOND QUARTERLY REPORT ON PROPELLANTS FOR ELECTRICAL PROPULSION ENGINES OF THE CONTACT OR BOMBARDMENT ION TYPE, JUNE 15 THROUGH SEPTEMBER 15, 1960. A. A. Cox (Rocketdyne Div., North American Aviation, Inc., Canoga Park, Calif.). Oct. 1960. 96p. Contract AF33(616)-7063.

A literature survey of properties of possible ion propellant materials was extended to cover the interhalogen compounds and sulfur hexafluoride. An apparatus was constructed for thermal stability studies, and experimental determinations are planned. Molar refractions, for the evaluation of molecular polarizabilities, were determined for anthracene and anthraquinone. A detailed description is included of the experimental techniques and methods of data interpretation. A design was prepared for construction of a charged colloid generator with an electron bombardment charging assembly, and the components of this apparatus are being detailed. (For preceding period see NP-9754.) (auth)

8405 (STI-Doc-10/2) PROSPECTS OF NUCLEAR POWER IN FINLAND. Technical Report Series No. 2. (International Atomic Energy Agency, Vienna and Finland. Atomic Energy Commission, Helsinki). Dec. 1960. 91p.

A survey of power use and development, and problems related to introduction of nuclear power in Finland is presented. A brief review of the general energy situation and an evaluation of the existing energy resources and the energy impacts of the country are given. Aspects of electric power generation and consumption are discussed along with the role of thermal energy in this program. A preliminary comparison of conventional and nuclear power costs at the time when a relatively large unit of either type could be operated on base-load is included and an estimate of future hydro and nuclear power costs is presented for comparison. It is concluded that threshold conditions for economic nuclear power in Finland may exist in 1970. (J.R.D.)

8406 (TID-6312) THE PRACTICAL APPLICATION OF SPACE NUCLEAR POWER IN THE 1960'S. J. R. Wetch, H. M. Dieckamp, and G. M. Anderson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 1961. 50p. Contract AT-11-1-GEN-8.

Nuclear reactor space electric power units under development in the U. S. include the SNAP-2, SNAP-8, and SNAP-10. The electric power output of these Systems for Nuclear Auxiliary Power (SNAP) extends over three decades of power, from 300 watts to 60 kilowatts. The major operational, installation, and handling characteristics of these nuclear power units are described. In particular, some limitations and restrictions with regard to payload, shielding, and radiation environment are described with respect to the power plants, their mode of installation, and system weight. The ground handling and safety, as well as the over-all safety, aspects of space reactor utilization are also described. The SNAP-10 power unit is a demonstration system that utilizes thermoelectric power conversion. The SNAP-2 power system utilizes a similar compact nuclear reactor, which is cooled with liquid sodium-potassium alloy, and coupled to a small mercury vapor turbine generator power conversion system. The SNAP-8 system is a direct outgrowth of the SNAP-2 power plant development. It will deliver 30,000 watts with one mercury vapor turbine generator system and weighs about 1400 lb. (auth)

8407 (TID-6792) A STATISTICAL SUMMARY OF THE PHYSICAL RESEARCH PROGRAM AS OF JUNE 30, 1960. (Division of Research, AEC). Sept. 1960. 43p.

A summary is presented of manpower and dollars expended in the AEC Physical Research Program. Figures are given for the major research centers, educational institutions, industrial laboratories, and research institutes. (T.R.H.)

8408 (TID-8531) COSTS OF NUCLEAR POWER. (Office of Operations Analysis and Forecasting, AEC). Jan. 1961. 43p. Replaces Report TID-8506 of July 1959.

The discussion on the costs of nuclear power from stationary plants, designed primarily for the generation of electricity, deals with those plants in operation, being built, or being designed for construction at an early date. An attempt is made to consider the power costs on the basis of consistent definitions and assumptions for the various nuclear plants and for comparable fossil-fuel plants. Information on several new power reactor projects is included. (auth)

8409 THE FUTURE OUTLOOK FOR NUCLEAR ENERGY IN EUROPE. F. Sardemann. Atomwirtschaft, 5: 499-502(Nov. 1960). (In German)

The future outlook for nuclear energy in Europe is assessed differently in two new reports from OEEC and Euratom. Euratom expects in 1980 for its six countries a nuclear energy share of almost 50% of the total electrical consumption of 950×10^{12} watt-hr and of over 30% of the then available total capacity. The OEEC anticipates for 1975 in all OEEC countries a proportion of nuclear power stations amounting to only 5 to 17.5%. (auth)

8410 THE FUTURE OUTLOOK FOR NUCLEAR ENERGY IN EUROPE. II. F. Sardemann. Atomwirtschaft, 5: 563-4(Dec. 1960). (In German)

The evaluation of nuclear energy needs in Europe is continued with a summary of the last report of Euratom. (tr-auth)

8411 NUCLEAR TECHNOLOGY. W. R. Tomlinson, Jr. (Johns Hopkins Univ., Bethesda, Md.). Ind. Eng. Chem., 52: 1030-7(Dec. 1960).

A review is given of recent advances in nuclear technology. The discussions are concerned with: the chemical processing of thorium and uranium ores; the chemical processing of plutonium, uranium, and plutonium-uranium nuclear fuels; stable isotopes; the production and application of radioisotopes; and radioactive waste. (221 references). (B.O.G.)

8412 SOME CONTRIBUTIONS FROM NUCLEAR POWER TO ENGINEERING PRACTICE. Ian Davidson (United Kingdom Atomic Energy Authority, Risley, Eng.). J. Brit. Nuclear Energy Conf., 6: 27-35(Jan. 1961).

Some facets of recent progress in engineering practice are illustrated which have been associated with the nuclear power program. Problems with large steel pressure vessels are briefly described and the means adopted to overcome them are discussed; the possible consequences on general engineering practice are mentioned. A similar treatment of the design and construction of concrete biological shielding indicates that in this case useful progress has been made in meeting nuclear requirements in such a way that largely conventional practice may be successfully applied. These two subjects lead to a proposal for large prestressed concrete pressure vessels, of which some basic design parameters are outlined. (auth)

8413 MAGNETOHYDRODYNAMIC POWER GENERATION. R. Hawley (Univ. of Durham, Newcastle-Upon-Tyne, England). Research (London) 13: 466-72(Dec. 1960).

Magnetohydrodynamic (mhd) power generation promises to be more efficient than present methods of generation. The ideas behind mhd generation and their development leading to the experimental generators that have been built are discussed. The extent of research into the many problems that remain to be solved in order that mhd power generation may become a commercial proposition is mentioned. (auth)

8414 OAK RIDGE SCIENCE DEMONSTRATION LECTURE PROGRAM. [SCIENCE TEACHER] HANDBOOK. (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.). Revised Dec. 1960. 121p.

The Traveling Science Demonstration Lecture Program was initiated in the 1956-1957 academic year as a program of assistance to secondary schools for the express purpose of stimulating interest in science, science teaching, and science careers. The handbook is divided into three sections: lecture notes, demonstrations, and diagrams of homemade apparatus; and is limited to the topics and related demonstrations utilized in the traveling science teacher program. (auth)

8415 18 QUESTIONS AND ANSWERS ABOUT RADIATION. (Atomic Energy Commission, Washington, D. C.). 1960. 51p.

Topics discussed include the nature of nuclear radiation; applications of nuclear radiation in medicine and industry; radiation sources; harmful effects of radiation; the amount and sources of radiation people in the United States and throughout the world are exposed to; standards for establishing maximum permissible exposure for individuals and maximum permissible concentrations for various types of radioactive materials; and ways in which the Atomic Energy Commission accomplishes protection of the public against the harmful effects of radiation. (C.H.)

8416 THE INDUSTRIAL CHALLENGE OF NUCLEAR ENERGY. III. STRESA CONFERENCE. PART II. ATOMIC LAW AND ADMINISTRATION. Paris, The Organisation for European Economic Co-operation, 1960. 264p. $3.00.

Atomic law and administration is discussed in this part of a survey on the nuclear power programs of Europe. Papers and discussions are grouped under four headings: atomic law, the communication of information and protection of inventions in the nuclear field, third-party liability and insurance of nuclear risks, and management problems. (M.C.G.)

8417 THE INDUSTRIAL CHALLENGE OF NUCLEAR ENERGY. III. STRESA CONFERENCE. PART III. THE MARKET FOR NUCLEAR MATERIALS. FUELS-MODERATORS. SPECIAL METALS. Paris, The Organisation for European Economic Co-Operation, 1960. 297p. $3.00.

The market for nuclear materials is described in this part of a survey of the nuclear power programs of Europe. The present and estimated future demands for uranium, moderator materials, and special metals are discussed. A comparison of costs for natural- and enriched-uranium fuel cycles is given. (M.C.G.)

8418 THE INDUSTRIAL CHALLENGE OF NUCLEAR ENERGY. III. STRESA CONFERENCE. PART IV. THE MARKET FOR NUCLEAR EQUIPMENT AND INSTRUMENTATION. Paris, The Organisation for European Economic Co-operation, 1960. 272p. $3.00.

The market for nuclear equipment and instrumentation is discussed as part of a survey of European nuclear power programs. Special characteristics of nuclear equipment, factors affecting cost, and nuclear instrumentation requirements are among the topics discussed. (M.C.G.)

8419 TRAVAUX PRATIQUES DE PHYSIQUE NUCLÉAIRE ET DE RADIOCHIMIE. (Practical Work in Nuclear Physics and Radiochemistry). M. Duquesne, R. Grégoire, and M. Lefort. APPENDIX I: NOTIONS DE PROTECTION CONTRE LES RADIATIONS IONISANTES. R. Devoret. 324p. (1960). Masson et Cie, Paris.

After a review of the ideas basic to practical work in nuclear physics and radiochemistry, a series of techniques is offered for the manipulation of radiation detection instruments and the study of nuclear physics. The introduction discusses atomic structure, nuclear structure, and interactions of radiation with matter. The first part deals with methods of detection of nuclear radiation including ionization chambers, pulse ionization chambers, probability and statistics and errors, counters, and nuclear emulsions. The second part, entitled Methods of Study of Nuclear Structure, includes chapters on half life of excited states, α, β, and γ spectrometry, research on coupling radiations—coincidence methods, quantum characteristics of levels, excitation of stable nuclei, nuclear reactions,

chemical phenomena associated with nuclear reactions, and applications of radioactivity and isotopes to problems in chemistry. Appendixes are given on protection against ionizing radiation and constants and unit systems. (T.R.H.)

8420 IMPROVEMENTS IN UTILIZATION OF NUCLEAR ENERGY. Thayer Lindsley. British Patent 859,352. Jan. 18, 1961.

A method is given for utilizing the thermal energy from a nuclear underground explosion for recovery of values of a nonmetallic mineral deposit. The method consists of converting the mineral to pyrolytic gaseous products and is applicable to recovery of SO_3 or H_2SO_4 from gypsum, CO_2 from limestone, and sulfur from pyrites or native sulfur, but its greatest utility and promise is in recovery of hydrocarbons from gas shales, tar sands, and other carbonaceous or bituminous materials. Thick high-molecular weight tars can be converted in this way to a mixture of flowable liquid hydrocarbons of low molecular weight. (D.L.C.)

BIOLOGY AND MEDICINE

General and Miscellaneous

8421 (ACRH-14) SEMIANNUAL REPORT TO THE ATOMIC ENERGY COMMISSION, SEPTEMBER 1960. Leon O. Jacobson, ed. (Argonne Cancer Research Hospital, Chicago). 115p. Contract AT(11-1)-69.

Separate abstracts were prepared on 11 sections of this report. A list is included of staff publications during the period. (C.H.)

8422 (ACRH-14(p.1-6)) THE KIDNEY AND ERYTHROPOIETIN. C. W. Gurney and L. O. Jacobson (Argonne Cancer Research Hospital, Chicago).

Ten years of intensive investigation into the fundamental nature of the stimulus for red-cell production have uncovered much evidence pointing to the central role played by a humoral stimulating factor, erythropoietin, in the regulation of this process. This substance appears to be a glycoprotein, present in the plasma of normal donors, and is markedly increased in the plasma of many anemic patients. The existence of a dynamic equilibrium of red cell production was postulated according to which, the rate of red-cell production is continuously regulated by the plasma titer of erythropoietin. The normal production of red cells, just sufficient to compensate for the normal daily destruction of approximately 1% of the circulating red-cell mass, represents the action of a small amount of erythropoietin on the stem cells in the bone marrow. Anemia or hypoxia, as well as the cobaltous ion, act to increase red-cell production indirectly by stimulating the production or increasing the liberation into the plasma of erythropoietin from some distant site. Jacobson et al., first demonstrated that one action of erythropoietin probably was to induce differentiation of primitive cells of the bone marrow. Alpen and Cranmore and Erslev have verified this conclusion by different methods, and have further presented evidence suggesting that this is the only important action of erythropoietin insofar as it pertains to red-cell production. The historical aspects of the study of erythropoietin, its chemistry, physiology, and clinical relevance were reviewed. In the last three years, interest has been focused upon the kidney as a source of erythropoietin production. Evidence is summarized and implications are discussed. 35 references. (auth)

8423 (ACRH-14(p.7-11)) ERYTHREMIA IN RENAL DISEASE. C. W. Gurney (Argonne Cancer Research Hospital, Chicago).

Erythropoietin was demonstrated both in the cystic fluid and the saline extract of a renal carcinoma obtained from two patients with erythremia. It is probable that this syndrome is more common than is generally appreciated. Polycythemia limited to the red-cell series and not obviously secondary to other disease warrants vigorous investigation of the kidneys. Successful removal of renal carcinoma may be anticipated when this early sign is heeded. Furthermore, the demonstration of erythropoietin in a renal tumor and in renal cystic fluid, while not absolutely conclusive, tends to support the concept that erythropoietin is produced by the kidney. 16 references. (auth)

8424 (ACRH-14(p.22-9)) HETEROLOGOUS TRANSPLANTATION OF MOUSE TUMORS INTO THE NEWBORN ALBINO RAT. J. S. Thompson and C. W. Gurney (Argonne Cancer Research Hospital, Chicago).

Results are reported from an investigation of the heterotransplantation of mouse tumors into newborn rats. An increased mortality generally occurs when any mouse tumor is inoculated into the rat during the first postpartum day. The exceptions appear to be those rats injected at birth with either myeloma or neuroblastoma. Many rats injected at birth with lymphoma L4946, lymphosarcoma 6C3HED, and Ehrlich Ascites tumors died with large expanding subcutaneous masses or ascites, although occasionally the tumors appeared to be regressing at the time of death. In addition, many of those rats injected with the lymphoma P1534 died after complete regression of the tumor, and quite pronounced mortality of the rat host occurred although no heterologous growth of either the mammary carcinoma BW10232 or the melanoma S91 could be observed. Many of these young rats demonstrated markedly stunted growth, sparse hair, a hunched posture, and sometimes diarrhea until death. Autopsy of these rats has revealed that the spleen is generally small, the thymus quite reduced, and that the mesenteric as well as other lymph nodes are usually absent. No other gross abnormalities are noticeable and the consistent histological feature is limited to a striking depletion of mature lymphoid elements, resulting in a great decrease of splenic white pulp and virtual absence of the cortical areas of the thymus. Sometimes necrotic residue of the lymphomas P1534 and L4946 could be identified microscopically in the thymus, but more often no recognizable tumor tissue was found. (auth)

8425 (ACRH-14(p.30-3)) SERUM PROTEIN ABNORMALITIES IN "RUNTED" ALBINO RATS. J. S. Thompson and C. W. Gurney (Argonne Cancer Research Hospital, Chicago).

When newborn albino rats are injected with either normal or neoplastic tissues of mouse origin, occasional animals will develop a wasting disease characterized by roughened scaly skin, sparse hair growth, failure to gain weight normally, and sometimes actual weight loss. This condition usually appears at 7 to 14 days of life and while many of the animals so afflicted succumb very shortly, others may survive for at least 35 days. Apart from sparse hair and stunted growth, these survivors are apparently normal. The same phenomenon is occasionally observed following intraperitoneal inoculation of normal adult DBA/2 mouse spleen cells into newborn albino rats, but it occurs much more frequently after subcutaneous, intraperitoneal, or intracerebral injection of one of several transplantable mouse tumors into this host. Furthermore, this disorder occurred rather frequently after inoculation of mammary carcinoma and melanoma, neither of which ever demonstrated palpable growth. This runted rat is interesting because it is grossly similar to the runts described in homologous transplantation studies. Autopsied animals dying

with the disorder reveal some of the general characteristics noted by Billingham and Brent; the spleen is small, the thymus absent or quite small, the mesenteric lymph node usually absent, and lymphogenous tissue generally reduced. When excluded from consideration those rats appearing underdeveloped at birth and those which were survivors of litters having a high initial mortality, only 6 animals which might be grossly classified as runts were encountered in 251 control rats injected with Tyrodes solution or not injected at all. Unfortunately, these were not autopsied, since the significance of the condition had not then been realized. In contrast, 15 of 23 rats inoculated at birth with the mammary carcinoma BW10232 developed the runting disease. Since other abnormalities of the reticuloendothelial system are probably present in the runted animals, we have begun an intensive investigation of the serum proteins. So far this investigation is limited to those animals surviving the first 5 weeks of life. At this age, normal littermates weight 75 to 100 g, whereas the runts weigh from 35 to 55 g. A preliminary report is presented on the serum protein fractions in these animals. (auth)

8426 (ACRH-14(p.34-43)) THE TUMOR-INHIBITORY EFFECTS OF 3-METHYLCHOLANTHRENE ON A TRANSPLANTABLE AND 3-METHYLCHOLANTHRENE-INDUCED TUMORS IN C3H MICE. J. S. Thompson, C. W. Gurney, and W. H. Kirsten (Argonne Cancer Research Hospital, Chicago).

Growth of myeloma X5563 in C3H mice was consistently depressed by 3-methylcholanthrene if treatment with this carcinogen was instituted within 3 days of tumor transplantation. In those mice with a palpable tumor mass the average weight of the resected tumors treated with sesame oil was twice as great as in those treated with 3-methylcholanthrene. The histological picture revealed a distinct contrast between tumors from mice treated with 3-methylcholanthrene and those from controls. In the latter, necrosis was usually not a prominent feature. It sometimes occurred in very large tumors, but always in a central location sparing the peripheral borders. Mitotic figures were quite prominent throughout and almost no fibrous tissue was present. The carcinogen-treated tumors revealed a great reduction in number of mitotic figures, many of which were bizarre. Peripheral necrosis and fibrosis were prominent features. In transition from these areas of frank necrosis, bizarre cells with disrupted nuclei and vacuolated cytoplasm were seen. A distinct infiltration with leucocytes, or normal plasma cells, however, was not characteristic. (auth)

8427 (ACRH-14(p.44-9)) CHARACTERISTICS AND MANUFACTURE OF RADIOISOTOPES FOR MEDICAL PURPOSES AT THE ARGONNE CANCER RESEARCH HOSPITAL. P. V. Harper (Argonne Cancer Research Hospital, Chicago).

Problems involved in the production and medical application of new and untried radioisotopes are discussed. A survey was made of isotopes decaying by electron capture and those emitting low-energy γ rays. The production of Pd^{103} is described and the possibility of using it as a therapeutic agent in cancer is discussed. The possibilities of using Cs^{131} as a source of therapeutic radiation in cancer is also discussed. The preparation of a Co^{60} model teletherapy source is described. Applications of I^{125} as a diagnostic aid are discussed. (C.H.)

8428 (ACRH-14(p.87-9)) OPTIMUM TREATMENT TIME IN COMBINATION THERAPY WITH ACTINOMYCIN AND IRRADIATION. K. Ranniger and M. L. Griem (Argonne Cancer Research Hospital, Chicago).

Among the drugs that have been used in conjunction with x rays in the treatment of malignancies are several Actinomycin compounds derived from cultures of Streptomyces. These antibiotics are reported to promote cytostatic activity in several experimental animal and human tumors and to potentiate the skin reaction of radiation. Whether they are capable of enhancing the effect of x rays upon tumors is still under discussion. Results are reported from experiments designed to determine the optimum time of administration of Actinomycin D in combination with irradiation in laboratory animals. These experiments confirm the results of other investigators who found that a single dose of 150 μg/kg of Actinomycin D had no cytostatic effect upon Walker 256 carcino-sarcoma. They show further that irradiation 1 and 4 hr following the administration of the drug may only slightly enhance the radiation effect. (auth)

8429 (ACRH-14(p.90-8)) STEROID FEVER STUDIES: PHYSIOLOGICAL DIFFERENCES BETWEEN BACTERIAL PYROGENS AND ENDOGENOUS STEROID PYROGENS OF MAN. A. Kappas, P. B. Glickman, and R. H. Palmer (Argonne Cancer Research Hospital, Chicago).

Previous studies from these laboratories have shown that a number of steroid metabolites of the 5 β type, derived from gonadal and adrenocortical hormones, provoke intense fever when injected into humans, and several aspects of the relation between chemical structure and thermogenic activity of these endogenous hormonal transformation products have been reported. These pyrogenic steroids include 19- and 21-carbon compounds of both the 11-desoxy and 11-oxygenated series such as etiocholanolone, 11-hydroxyetiocholanolone, pregnanediol, pregnanolone, and 11-ketopregnanolone. Typical examples of the fever produced in man by these compounds are shown. Studies on the mechanism by which these steroids produce fever in man have led to a comparison of their biological properties with those of bacterial pyrogens and a number of differences have been demonstrated. Results are summarized. (auth)

8430 (ACRH-14(p.99-112)) ENZYMATIC INCORPORATION OF RIBONUCLEOSIDE TRIPHOSPHATES INTO THE INTERPOLYNUCLEOTIDE LINKAGES OF RIBONUCLEIC ACID. S. B. Weiss (Argonne Cancer Research Hospital, Chicago).

An enzyme system isolated from rat-liver nuclei was found to catalyze the incorporation of labeled ribonucleoside triphosphates into ribonucleic acid. The enzymatic activity was dependent on the presence of all four ribonucleoside triphosphates. Evidence is presented which shows that the incorporation of labeled ribonucleoside triphosphate occurs throughout the entire polynucleotide chain. 31 references. (auth)

8431 (HW-66306) RESEARCH AND DEVELOPMENT ACTIVITIES IN THE FIELD OF RADIOLOGICAL SCIENCES. Quarterly Progress Report, April–June 1960. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 5, 1960. 40p. Contract AT(45-1)-1350.

Progress is reported in the following studies: the toxic effects of fission products in reactor effluent on the development of fish; the toxic effects of Sr^{90} fed to miniature swine; the response of skin to intradermal injections of plutonium nitrate; the response of irradiated miniature swine to transplants of fetal hematopoietic cells and adult bone marrow; the effects of chelating agents on the absorption of injected plutonium in swine; the mechanisms involved in gastrointestinal radiation injury; factors affecting the deposition of plutonium dioxide in the lungs of dogs; the toxic effects of inhaled plutonium dioxide in dogs; the radiosensitivity of

yeast cells; the uptake of Sr^{85}, Ca^{45}, and Cs^{137} by plants; levels of fall-out radioactivity in plants and animals collected at Cape Thompson, Alaska, during 1959; the concentration of β-emitting radioisotopes in wild animals from the Hanford area; studies on the diffusion and transport of dust particles using fluorescent tracer particles; the development of design modifications in equipment for use in personnel and environment monitoring programs; the performance of a whole-body radiation monitor; the formation of reactor effluent radioisotopes by the reactions $Al^{27}(n,\alpha)Na^{24}$, $Fe^{54}(n,p)Mn^{54}$, and $Fe^{58}(n,\gamma)Fe^{59}$; the mechanism responsible for the production of Sc^{45} in aluminum reactor process tubes; the effectiveness of alum flocs in removing arsenic from river water; effectiveness of ion exchange materials for the separation of Na^{24}, Zn^{65}, Np^{239}, and Cr^{51} from water; the geology of the Hanford area; the effectiveness of sampling wells in monitoring the water in an aquifier; the influence of solution pH on anion replacement reactions in soil; laboratory research to characterize the soil chemistry of rare-earth elements; mineral fixation of high-level wastes; parameters controlling the deposition of particles in conduits due to turbulent diffusion; and the efficiency of filters in removing air-borne fission products. (For preceding period see HW-64945.) (C.H.)

8432 (NASA-TN-D-781) FIRST PLANNING CONFERENCE ON BIOMEDICAL EXPERIMENTS IN EXTRA-TERRESTRIAL ENVIRONMENTS, HELD UNDER THE AUSPICES OF THE NASA, WASHINGTON, D. C., JUNE 20, 1960. (National Aeronautics and Space Administration, Washington, D. C.). Feb. 1961. 86p.

The objectives, important areas of inquiry, and program priorities for space environment biomedical experiments are discussed. Emphasis is recommended on the following: detection and study of extraterrestrial life; studies of the effects of simulated extreme environments; cellular and biological system studies in space conditions; ways and means of decontaminating space probes and vehicles; effects of space on biological rhythms and animal orientation; and photosynthesis in ecosystems. It was urged that space related work be carried out in earth-bound laboratories as well as in simulated environments and in upper atmospheric balloons. (auth)

8433 (TID-11135) PROGRESS REPORT ON IMPREGNATION OF RUBBER BALLOONS WITH RADIOACTIVE ISOTOPES. December 1, 1960. (Columbia Univ., N. Y.). 16p. Contract AT(30-1)-2086.

Progress is reported in the development of techniques for the treatment of patients suffering from multiple papillomatosis using β-emitting Foley balloon catheters containing Ag^{111}. Data are presented on the preparation of such catheters and measurements of dosage in dogs. (C.H.)

8434 (TID-11645) RADIOIODINE STUDIES OF FETAL AND OTHER THYROIDS. Technical Progress Report. [(Iowa. State Univ., Iowa City)]. Jan. 1961. 13p. Contract AT(11-1)-291.

Preliminary results are presented from studies on the uptake of I^{131} by human fetal thyroid glands after radioiodine had been given to the mother. Results are summarized on a total of 26 fetal thyroids. Data show that iodine uptake can be demonstrated as early as the twelfth week. The histologic appearance of the thyroid glands is correlated with accumulation of iodine. Radioautograms were prepared of each fetal thyroid. Data are included on levels of bound iodine in blood plasma during pregnancy. It is concluded that the period of fetal development from 21 to 23 weeks may be critical for radioiodine-induced damage. The possibility of genetic damage from the administration of I^{131} during pregnancy is discussed. Measurements were made of I^{131} accumulation in ovarian tissue at different times after administration. In some cases the ovarian studies were combined with fetal thyroid studies. (C.H.)

8435 (TID-11700) ATTEMPTS TO DELINEATE INBORN ANEMIAS IN MICE. Progress Report and Sixth Renewal Proposal, Report Period: February 1, 1960–Janaury 31, 1961. Renewal Period: May 1, 1961–April 30, 1962. Elizabeth S. Russell and Seldon E. Bernstein (Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.). Jan. 31, 1961. 22p. Contract AT(30-1)-1800.

Remarkable success was obtained using normal fetal hematopoietic liver implants for the cure of W-series severe macrocytic anemias, both in completely compatible combinations and in one instance where there was a minor histocompatibility difference between host and donor. Other therapy studies include evaluation of effect upon success of implantation of tissue source and of host irradiation and comparison of effectiveness of parent-strain and isologous F_1 hybrid donor tissues. Analysis of the cellular basis of the great difference between ww and WW^v animals in sensitivity to 200 r whole-body irradiation, through studies of marrow cellularity and level of peripheral erythrocytes and leukocytes indicates that the defect is not at all related to number of circulating leukocytes but is closely related to delayed regeneration of erythroid elements. Single doses of W and W^v also have significant effects upon acute radiosensitivity. Ww and W^vw mice that have received implants of ww blood-forming cells appear to have significantly increased radioresistance, indicating that acute radiosensitivity depends upon the genotype of functioning blood-forming tissue. Although ww and WW^v anemic mice respond equally to the erythropoietic stimulus of oxygen deprivation, WW^v animals fail completely to respond to doses of exogenous purified erythropoietin which cause great hematopoietic activity in ww mice. This failure to respond to erythropoietin also depends upon the genotype of blood-forming tissue, since WW^v mice implanted with ww tissue respond normally. Additional areas of investigation include characterization of other hereditary anemias, studies of a specific radiation protection factor, studies of biochemistry of blood formation through studies of rate of incorporation of heme precursors into hemoglobin of normal and anemic mice, and studies of fetal hematopoiesis. Publications have appeared on the genetic aspects of implantation of blood-forming tissue and on gene action controlling blood formation. (auth)

8436 (TID-11728) THE EFFECT OF HMD ON BODY WEIGHT AND ERYTHROPOIESIS IN RATS, DOGS, AND MONKEYS. R. J. McAlpine (Parke, Davis and Co., Detroit). Dec. 8, 1960. 15p.

A number of steroid compounds were screened for their effect on body weight and erythropoiesis in rats, dogs, and monkeys. Data are tabulated. The effects of an anabolic agent (HMD) on weight gain, hematocrit, and hemoglobin were studied in mature and immature animals. Data are presented graphically. (C.H.)

8437 (UCLA-469) SEMIANNUAL PROGRESS REPORT FOR THE PERIOD ENDING DECEMBER 31, 1960. (California. Univ., Los Angeles. School of Medicine). 107p. Contract AT(04-1)-GEN-12.

Progress is reported in the following studies: the radiation chemistry of dilute aqueous solutions of potassium oleate; the optical rotary dispersion in the region 226 to 366 mu of tobacco mosaic virus, the protein subunits isolated therefrom, the rods synthesized from the protein subunits, and the ribonucleic acid isolated from the virus;

the effect of metabolites on enzyme changes in single beating heart cells in culture; the relation of mitochondrial metabolism and glycolysis in dialyzed rat liver supernatant; the development of a system consisting of finely divided anthracene, a wetting agent, and an aqueous solution for determining α or β emitting isotopes in equipment designed for liquid scintillation counting; the effect of ionizing radiation on iron porphyrin compounds; the reaction of ferriprotoporphyrin with hydrogen peroxide in alkaline solution; the effects of tritiated compounds on Escherichia coli; the effects of estrogen treatment on the physiology of the liver of the chicken embryo and chick; the effects of estrogens on levels of protein bound carbohydrates in embryo and chick serum; the toxic effects of chronic oral sodium chloride in irradiated rats; the toxicity of niobium chloride in mice and guinea pigs; the effects of x irradiation on the response of the guinea pig enteric ganglia and postganglionic nerve endings to drugs; the effects of x irradiation on conditioned avoidance responses in rats; the effects of whole-body irradiation of cats on the production of electrical changes in the brain; the effects of whole-body x irradiation on stimulation of rat brain; histological and physiological changes induced by radiation in epithelial cells of the villi of rat intestine; the effects of Sr^{90} beads implanted within rat femur; the fate of lymphocytes after whole-body irradiation; the development of a technique for the irradiation of lymphocytes in freshly drawn blood; tracer studies on the rate of formation of cerebrospinal fluid; dysfunction of the central nervous system during concussion; development of analytical procedures for the spectrographic determination of zinc, copper, magnesium, iron, and phosphorus in tissues; the preparation of heat denatured colloidal aggregates of albumin labeled with I^{131} and nonradioactive colloidal aggregates of albumin; measurements of the rate of blood clearance following intravenous injection of colloidal aggregates of heat denatured human serum albumin labeled with I^{131} and colloidal Au^{198}; the development of a tracer method for estimating phagocytic and digestive functions of the reticuloendothelial system in man; tracer studies on liver blood flow and cellular function in patients with congestive heart failure; a comparison of results from renal function tests using conventional and Hippuran I^{131} excretion in patients with mild to severe renal disease; tracer studies of liver blood flow in hepatobilary diseases; the development of tracer methods for the diagnosis of diseases of the liver, kidneys, and spleen; the development of a dye-impregnated plastic film system for use in the measurement of depth dose distribution of ionizing radiations; the evaluation of two types of chemical dosimeters for dosimetry of prompt and residual radiations from nuclear detonations; tracer studies on the concentration of phosphate ions in the blood during a prolonged intravenous infusion of calcium lactate; the metabolism of Sr^{85} in patients with metabolic skeletal disorders; measurement of total-body radioactivity in normal individuals and in normal subjects after the administration of cobalt-60-labeled vitamin B_{12}; an evaluation of survival time curves in radiation mortality studies on mice; the effects of rate of radiation on the protection afforded mice by a combined dose of AET and 5-HT; the effect of radiation exposure on kidney function in rabbits as measured with iodopyracet labeled with I^{131}; the kinetics of reticuloendothelial phagocytic response to intravenously administered colloidal gold-198 in rabbits; the effects of radiation injury on the phagocytic capacity of the reticuloendothelial phagocytic response in rabbits; the γ scintillation measurement of blood levels of intravenously-administered I^{131} labeled iodopyracet in rabbits; tracer studies of liver blood flow and cellular function in rabbits during development of experimental hepatic cirrhosis; measurements of liver blood flow in rabbits with colloidal Au^{198}; preliminary studies on the induction of mouse leukemia with purified nucleic acid preparations from leukemic and normal mice; studies on the influence of irradiation and inflammation on the functions of the reticuloendothelial and erythropoietic systems; the uptake of fission products by plants from contaminated soils; the influence of calcium and strontium amendments on Sr^{90} uptake by clover; a comparison of the uptake of Sr^{90} and Cs^{137} by bryophytes and vascular plants; the distribution, characteristics, and biological availability of fall-out debris originating from testing programs at the Nevada Test Site; the influence of chelates on the uptake of Y^{91}, Sr^{90}, Zn^{65}, and Cs^{37} by bean plants; the influence of potassium and cesium on the uptake of Cs^{137} by bean plants grown in soils and nutrient solution; factors influencing plant uptake of Sr^{90} and its distribution within plants; the effects of irradiation from mixed fission product uptake on plants grown on contaminated agricultural soils; the metabolism of plants affected by lime-induced chlorosis; the utilization of carbonate fixed by roots of plants; population density and dispersal in desert rodents at the Nevada Test Site; the growth of confined populations of deer mice under chronic irradiation; levels of Sr^{90} in the jaw bones of California deer; food habits of the black-tailed jack rabbit; the radioactivity of tissues of rabbits collected at the fall-out area of Kiwi A nuclear propulsion device test area; the ratios between Cs^{137} and Sr^{90} in agricultural soils; and preliminary studies of plant ecology in desert environments. A list is included of publications during the period. (For preceding period see UCLA-466.) (C.H.)

8438 (UR-582) STUDIES ON THE EQUILIBRATION OF MERCURY VAPOR WITH BLOOD. T. W. Clarkson, John Gatzy, and Charlotte Dalton (Rochester, N. Y. Univ. Atomic Energy Project). Nov. 23, 1960. 63p. Contract W-7401-eng-49.

Studies were made on the rate of uptake of mercury by plasma, whole blood, and solutions of hemoglobin during equilibration with mercury vapor. Data are tabulated on mean values. Ultrafiltration and paper electrophoresis indicated that all the mercury in plasma was bound to serum albumin, whether added directly as $HgCl_2$ or by equilibration with vapor. Not all the mercury in hemoglobin solutions is bound to the protein. The nonprotein bound portion ranged from 12 to 77%, depending on the molar ratio of mercury to hemoglobin. A scheme was proposed for the mechanism of uptake of mercury vapor by whole blood. The essential step is the oxidation of elemental mercury to the divalent ion. Eighty-four per cent of this oxidation takes place inside the red blood cell and 26% in the plasma. The physiological significance of these findings are discussed. (auth)

8439 (USNRDL-TR-487) TURNOVER RATE, TURNOVER TIME AND COMPARTMENT SIZE IN THE STEADY STATE. M. L. Shore and A. K. Davis (Naval Radiological Defense Lab., San Francisco). Dec. 13, 1960. 40p.

Complex metabolic steady-state systems in which a central compartment (blood) exchanges compounds with independent peripheral compartments (tissues), with synthesis and loss of compounds occurring in the system, are examined. Factors that result in the simplification of complex biological systems into two-compartment open systems are discussed. Equations are derived for the two-compartment open system which allow the calculation of compartment size for the central and the combined peripheral compartments, the total rate of exchange between these

compartments, and the total rate of synthesis and loss of compounds from the system. Data required for these calculations can be obtained with relative ease from the accessible central compartment. Thus a tracer dose of a labeled compound is introduced into the central compartment, and the specific activity-time relations of the compound are determined. Values derived by graphical analysis of this curve, and knowledge of the dose of label administered are the only primary data needed to determine the parameters of the system. Practical applications of this analysis to model and biological systems are presented. (auth)

8440 (AEC-tr-4352) HOMOLOGOUS AND HETEROLOGOUS GRAFTS ON THE HEMATOPOIETIC SYSTEM. D. W. Van Bekkum. Translated from La Semaine des Hôpitaux, No. 13-14, 1083-1104 (July 1958). 28p.

Reactions involved in the transplantation of homologous and heterologous grafts of hematopoietic tissue are discussed. The mechanisms of the therapeutic effect of bone marrow after lethal irradiation and in leukemia are reviewed. Other topics discussed include the identification of host and donor cells; conditions of transplantation of hematopoietic tissue; methods of tissue preservation; the amount of transplanted tissue needed; implantation of the spleen; injection of spleen suspension; the therapeutic effects of bone marrow suspensions; antigenic differences between host and donor; the dosage and the nature of irradiation; the interval between irradiation and administration of hematopoietic cells; and the possibilities of transplanting bone marrow. 94 references. (C.H.)

8441 (AEC-tr-4353) LABELING OF PLANTS WITH C^{14}. D. Sauerbeck. Translated by Lydia Venters (Argonne National Lab.) from Atompraxis No. 6: 221-5(1960). 13p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, as abstract No. 22724.

8442 SECRETION OF RADIOACTIVITY IN MILK FAT AFTER A SINGLE ORAL DOSE OF (^{3}H) MYRISTIC ACID TO A GOAT. L. Reinius and J. Hasan (Inst. of Occupational Health, Finland). Acta Chem. Scand., 14: 1503-8(1960). (In English)

Tritium-labeled myristic acid was administered orally as free acid to a lactating goat, and then the secretion of the radioactivity in the total milk lipids and milk glyceride fatty acids was followed for thirteen days. Measurable activity was found in the milk fat 4 hr after administration and the maximum specific activity occurred within 28 hr. About 10% of the radioactivity administered was recovered during the experimental period, and about 25% of the activity collected during 13 days was secreted in the first 28 hr. In the beginning the nonvolatile fatty acids had a higher specific activity than the volatile fatty acids, and there seemed to be a tendency for the specific activities in the short chain acids to increase with time; whereas the long-chain acids appeared to be less active later in the experiment. (auth)

8443 CHEMICAL AND BIOLOGICAL STUDIES WITH DEUTERIUM. Joseph J. Katz. Am. Scientist, 48: 544-80 (Dec. 1960).

A basic flowsheet is presented for the production of deuterium oxide by the H_2O/H_2S dual-temperature exchange process. Cost factors are discussed. The physical properties of H_2O and D_2O are compared. It is shown that the substitution of hydrogen by deuterium in water gives rise to marked changes in physical properties. Applications of deuterium in chemical and biological studies are reviewed. Topics discussed include kinetic isotope effects of deuterium compounds; reaction rate phenomena which are known to exhibit isotope effects; the deuterium isotope effect in living systems; the growth of algae in heavy water; a comparison of ordinary and deuterated algae; the isolation of deuterated chloroplast pigments and other fully deuterated compounds from algae; photosynthesis in deuterated green algae; deuterium isotope effects on mammals; deuterium isotope effects on tumor growth; and the preparation of compounds in which hydrogen is replaced by deuterium. (C.H.)

8444 MEDICAL ASPECTS OF THE UTILIZATION OF RADIOACTIVE ISOTOPES. L. M. Van Putten. Atoomenergie, 2: 182-5(Nov. 1960). (In Dutch)

The order of magnitude of the incidence of deleterious effects of low doses of ionizing radiation in man is estimated. On the basis of this estimate, a rational evaluation of the medical use of radioisotopes is outlined. An attempt is made to evaluate certain aspects of the industrial use of radioisotopes on a similar basis. (auth)

8445 FOOD PRESERVATION BY IONIZING RADIATION. Harlan W. Nelson (Battelle Memorial Inst., Columbus, Ohio). Battelle Tech. Rev., 10: 8-15 (Jan. 1961).

The possibilities of food preservation by ionizing radiation are discussed from the standpoint of effectiveness and cost. The present status of this method of food preservation is described with respect to meats, poultry, seafood, vegetables, fruits, inhibition of sprouting, grain disinfestation, and milk. The effects of irradiation on food wholesomeness, nutritive value, toxicity, and activity are discussed. The current research programs in this field are described; most of those in the U. S. are conducted by the military services and the Dept. of Defense. (D.L.C.)

8446 THE LEICESTER GONAD PROTECTOR: A DEVICE TO AFFORD LOCALISED PROTECTION FROM DIAGNOSTIC X IRRADIATION. G. Whitehead and J. T. Griffiths (Leicester Royal Infirmary, Eng.). Brit. J. Radiol., 34: 135-6(Feb. 1961).

Design features are described for a device for protecting the gonads from primary exposure during diagnostic x irradiation. The device can be rapidly adjusted to take account of different types of examination, and of the age and sex of the patient. It provides a visible indication of the protection provided by the equipment. (C.H.)

8447 RADIOACTIVE IODINE IN THE TREATMENT OF HYPERTHYROIDISM (EXPERIENCE AT THE TORONTO GENERAL HOSPITAL, 1950-58). PART II. POST-I^{131} THYROIDITIS. Robert Volpe, Douglas L. Schatz, Aileen Scott, Joseph A. Peller, Joan M. Vale, Calvin Ezrin, and MacAllister W. Johnston (Univ. of Toronto and Toronto General Hospital). Can. Med. Assoc. J., 84: No. 1, 37-42 (Jan. 7, 1961).

Clinical findings are reported on a group of hyperthyroid patients treated with I^{131}. In virtually all cases of diffuse goiters, as well as postthyroidectomy recurrent goiters, the goiter regressed to a normal or subnormal size. In the toxic nodular group there was invariably a reduction in size of the goiter, which occasionally was complete. More often, nodules persisted although the glands were much smaller in size. Data are included on the incidence of transient hypothyroidism after I^{131} therapy, the number of doses of I^{131} in the entire group and in those becoming hypothyroid, and the causes of death during a two-year period following I^{131} therapy. (C.H.)

8448 RADIOACTIVE IODINE IN THE TREATMENT OF HYPERTHYROIDISM (EXPERIENCE AT THE TORONTO

GENERAL HOSPITAL, 1950-58). PART III. POSSIBLE BIOLOGICAL HAZARDS FROM RADIOACTIVE IODINE THERAPY. Robert Volpe, Douglas L. Schatz, Aileen Scott, Joseph A. Peller, Joan M. Vale, Calvin Ezrin, and MacAllister W. Johnston (Univ. of Toronto and Toronto General Hospital). Can. Med. Assoc. J., 84: No. 2, 84-7 (Jan. 14, 1961).

A review of 542 hyperthyroid patients treated by I^{131} at the Toronto General Hospital between 1950 and 1958 is presented. This group included 403 patients with diffuse hyperplastic goitre and 139 patients with toxic nodular goitre. The method for assessing the initial dose of I^{131} is described. In general, patients with toxic nodular goitres received much larger doses. Of the diffuse hyperplastic group, 72% were cured with one dose, the remainder requiring two or more doses. A greater percentage of the toxic nodular group required only one dose. No cases of complete resistance to I^{131} therapy were encountered. Permanent hypothyroidism was produced in 16.3% of those so treated, but in 6.5% it was very mild. The incidence of clinical hypothyroidism was much lower in the toxic nodular group than in the diffuse hyperplastic group. There was a continuing incidence of late hypothyroidism, occurring years after therapy; some of these patients had undergone a transient period of hypothyroidism shortly after treatment, then recovered for some years. Factors possibly related to the response to treatment and to the development of hypothyroidism have been analyzed. Recurrent hyperthyroidism after thyroidectomy was associated with a significant increase in the incidence of post-I^{131} hypothyroidism, while pretreatment with antithyroid drugs seemed to reduce radiosensitivity in the diffuse group. No late recurrences of hyperthyroidism were noted. Twenty-one deaths occurred within two years of therapy. In most, there was no obvious relation to therapy, while in none was there a clear-cut cause-and-effect relationship to I^{131} therapy. Nevertheless, elderly or very ill patients should be treated only after they have been rendered euthyroid by antithyroid drugs. Fertility has not been affected by I^{131} therapy, but the use of this isotope in pregnancy is contraindicated because of the possible ill effects on the fetus. The possibility of genetic effects appears to be negligible, as judged by the gonadal radiation doses received in I^{131} therapy. The fear of carcinoma of the thyroid likewise appears to be receding if the therapy is utilized only in adults. Leukemia has been reported in 14 instances. However, the statistical import is not clear, since the total number of cases of leukemia and of persons treated by I^{131} is not known. It may be that there is a slight increase in the incidence of leukemia following radioactive treatment, comparable to that possibly induced by certain diagnostic radiological procedures, but this is insufficient to warrant any change in policy regarding the use of I^{131}. After consideration of these hypothetical dangers, it is concluded that the use of radioactive iodine is a safe, effective form of therapy for adult, nonpregnant hyperthyroid patients, and is to be preferred to surgical thyroidectomy. 108 references. (auth)

8449 THE EFFECT OF CERTAIN CHEMICAL AND PHYSICAL AGENTS ON THE RADIATION SENSITIVITY OF MOUSE TUMORS. Robert K. Modlin and John McL. Morris (Yale Univ., New Haven). Cancer, 14: 117-25 (Jan.-Feb. 1961).

By a technique employing transplanted mouse tumors, the following observations were made on radiation sensitivity: Intravenous administration of glutathione prior to radiation therapy increased radiation resistance and significantly lowered the tumor remission rate; this effect could be reversed by concomitant testosterone administration; testosterone administered alone produced a more favorable response initially but this was not significant after 40 days; increased temperature appeared to accelerate radiation response of the tumors and produced marked increase of the normal tissue without improving the ultimate remission rate. There was a suggestion that cold might delay radiation response; anoxia produced by a tourniquet appeared to decrease radiation sensitivity of both tumor and normal tissue; and surgical incision into the tumor 1 hr prior to radiation therapy improved the remission rate of the tumors. Incisions 3 days after radiation therapy had somewhat less effect, but there was no evidence that surgery interfered with tumor radiation response. (auth)

8450 RADIOISOTOPE STUDIES OF GENERALIZED SKELETAL DISORDERS. VITAMIN D RESISTANT RICKETS. William Meltzer, Irving Lyon, Esther D. Mensen, and Robert D. Ray (Presbyterian-St. Luke's Hospital, Chicago and Univ. of Illinois Coll. of Medicine, Chicago). Clin. Orthopaedics No. 17, 269-87 (1960).

Applications of bone-seeking radioactive isotopes in studies of generalized skeletal disorders are reviewed. Results are reported on two cases of vitamin-D-resistant rickets and one normal patient studied with Sr^{85}. (C.H.)

8451 PREPARATION OF TRITIUM LABELLED ANTIBIOTICS. G. Giovannozzi-Sermanni and E. Possagno (Università, Rome). Energia nucleare (Milan), 7: 797-800 (Nov. 1960). (In English)

The preparation and purification by column chromatography of radioactive antibiotics prepared by random tritiation are described. Penicillin G, penicillin V, chlortetracycline, tetracycline, streptomycin, dihydrostreptomycin, and chloramphenicol were prepared. (auth)

8452 CAESIUM-137 LABELLED ALGAE FOR FILTRATION STUDIES. K. J. Ives (University Coll., London). Intern. J. Appl. Radiation and Isotopes, 9: 49-53(Dec. 1960). (In English)

A method is described whereby the green algae Chlorella and Scenedesmus were cultured in a growth medium containing Cs^{137}. These radioactive algae were used as a suspension in water passing through a column of filter sand. The distributions of the algal cells retained in the filter were measured with a scintillation counter mounted externally to the column. Calibrations of the shielded scintillation counter for the amount of activity per algal cell and for the geometry of the filter column are described. (auth)

8453 COMPARTMENTALIZED PHANTOMS FOR THE STANDARD MAN, ADOLESCENT AND CHILD. R. L. Hayes and Marshall Brucer (Oak Ridge Inst. of Nuclear Studies, Tenn.). Intern. J. Appl. Radiation and Isotopes, 9: 113-18 (Dec. 1960). (In English)

A compartmentalized phantom for the standard man was designed and built of readily available and inexpensive materials. Similar phantoms were also designed for an adolescent and a child. The basic emphasis in the designs is on general utility so that a variety of different dose-measurement techniques could be used on the same phantom. The designs are, however, in reasonable agreement with anthropometric data reported in the literature. The phantoms proved to be extremely useful in depth-dose and energy-absorption measurements for total-body irradiation therapy. Dose measurements with beam teletherapy, brachytherapy devices, and internally distributed radioisotopes were also made. (auth)

8454 TRANSPLANTATION OF CHIMERIC BONE MARROW. Otto Vos, Joan Wright Goodman, and C. C.

Congdon (Oak Ridge National Lab., Tenn.). Intern. J. Radiation Biol., 3: 29-39(Jan. 1961). (In English)

Retransplantation of bone marrow was studied in an attempt to understand why fetal liver was superior to adult bone marrow in the treatment of lethally-irradiated mice. Presensitization experiments, in which recipients were immunized against cells of the future donor strain, were performed. In this system fetal-liver-chimeric spleen cells were as effective antigenically as those taken from adult-bone-marrow chimeras. Fetal-liver-chimeric bone marrow, used to protect irradiated mice that had been presensitized to normal homologous donor-type cells, was as ineffective as that from normal mice of comparable strain. From these results an unaltered sensitivity of the fetally-derived chimeric cells to specific isoantibodies was deduced. The findings are discussed in relation to several postulates offered to explain the ameliorating effect of fetal liver on homologous disease in radiation chimeras. Investigations failed to show a loss of either isoantigenicity or sensitivity to specific antibodies on the part of chimeric cells of fetal origin. The superiority of chimeric cells of fetal origin over those of adult-marrow origin in retransplantation bone-marrow experiments is consistent with a tolerant state of fetally-derived donor cells to the host strain. (auth)

8455 THE RADIOPROTECTIVE ACTION OF DIMETHYL SULPHOXIDE AND VARIOUS OTHER SULPHOXIDES. M. J. Ashwood-Smith (Medical Research Council Radiobiological Research Unit, Harwell, Berks, Eng.). Intern. J. Radiation Biol., 3: 41-8(Jan. 1961). (In English)

A number of sulfoxides and derivatives of dimethyl sulfoxide were tested for radioprotective action against a lethal dose of x rays in mice. Of the sulfoxides tested, only dimethyl sulfoxide showed appreciable protective activity, in that it conferred a 70% protection against a lethal dose of x rays. The dose-reduction factor for dimethyl sulfoxide was found to be 1.33, as compared with 1.45 for A.E.T. Of the other sulfoxides tested, only five possessed weak protective activity. These were methyl ethyl sulfoxide, tetramethylene sulfoxide, dl-methionine sulfoxide, di-phenyl sulfoxide, and bis-tribromomethyl sulfoxide. It seems unlikely that either dimethyl sulfide or dimethyl sulfone is involved in the mechanism of dimethyl sulfoxide protection. (auth)

8456 RADIATION-PROTECTION BY SOME SULPHYDRYL DERIVATIVES OF PYRIDOXINE AND A NEW BAL PREPARATION. B. A. Bridges (Wantage Radiation Lab., Berks, Eng.) and R. Koch. Intern. J. Radiation Biol., 3: 49-58(Jan. 1961). (In English)

5-Mercaptopyridoxine was shown to be a protective agent against ionizing radiation for mice and Escherichia coli strain B/r, whereas pyridoxine was inactive. 4,5-Dimercaptopyridoxine protected bacteria but not mice. The lack of effect with mice might be due to the greater toxicity of the disulfhydryl compound, which prevents the administration of an adequate dose for protection. The protective effect of both sulfhydryl derivatives on E. coli was abolished by irradiating under aerated conditions, suggesting that the mechanism involves the production of anoxia. BAL-sulfonic acid showed a protective effect with mice in contrast to other experiments with normal BAL. The cysteine–cysteamine configuration is therefore shown to be unnecessary for the protective action of sulfhydryl compounds. (auth)

8457 STUDIES OF MECHANISMS OF CHEMICAL RADIATION PROTECTION IN VIVO. I. 5-HYDROXYTRYPTAMINE IN RELATION TO EFFECT OF ANTIMETABOLITES, ANTAGONISTS AND RELEASING AGENTS. H. A. S. Van Den Brenk and Magda Haas (Cancer Inst. Board, Melbourne). Intern. J. Radiation Biol., 3: 73-94(Jan. 1961). (In English)

The radioprotective action of 5-hydroxytryptamine (5HT) in rats is specifically reversed by 5HT antimetabolites and antagonists of the β-haloalkylamine group, which block D receptors on smooth muscle cells. This reversal is not obtained with those antihistamines that have a very weak antiserotonin activity, despite their reversal of histamine protection. There is no correlation between the extractable 5HT in rat tissues, using bioassay techniques, and the radioprotection induced by exogenous administration of 5HT, by the anti-5HT-brominated lysergic acid (BOL), or by reserpine, singly or in combination. The sudden endogenous release of tissue 5HT gives radio-protection, but depletion of such endogenous 5HT by reserpine fails to alter radiosensitivity in vivo. There is no correlation between hypothermia and radiosensitivity of rats in respect to 5HT and reserpine. The precursor of 5HT in metabolism, 5-hydroxytryptophan as the L antipode, fails to afford protection against ionizing radiations quantitatively similar to 5HT; the slight protection which results is probably due to the formation of the amine in vivo following decarboxylation. The results fail to support the protective action of 5HT in terms of either radical capture or the formation of radio-resistant amine-macromolecule complexes. The results favor a simple exposition of 5-hydroxytryptamine protection in terms of pharmacologically induced tissue anoxia and a reduction in the oxygen effect. (auth)

8458 INABILITY OF DIMETHYL SULPHOXIDE TO PROTECT MOUSE TESTIS AGAINST THE EFFECT OF X-RADIATION. M. J. Ashwood-Smith (National Inst. for Medical Research, London). Intern. J. Radiation Biol., 3: 101-3(Jan. 1961).

No protection was afforded by dimethyl sulfoxide against radiation injuries to the testis in rats and mice. Dimethyl sulfoxide was found to concentrate in testes after intraperitoneal injection. Data are included on changes in weight and histology in testes of treated and untreated, irradiated and nonirradiated mice. (C.H.)

8459 NUCLEIC ACIDS IN DEUTERIUM OXIDE SOLUTION. Y. Kyogoku, M. Tsuboi, T. Shimanouchi, and I. Watanabe (Tokyo Univ.). Nature, 189: 120-2(Jan. 14, 1961).

Observations on the infrared spectra of certain nucleosides led to the conclusion that the specific pairings of cytosine-guanine and adenine-uracil generally postulated in nucleic acid structures involve proton transfer from uracil to guanine to adenine or cytosine, and that such pairings cause strong absorptions in the vicinity of 1710 cm^{-1}. Specific base-base interaction was much weaker in dry films than in wet films. Data are included on the infrared absorption spectra of desoxyribonucleic acid and ribonucleic acids in deuterium oxide solutions at various temperatures. (C.H.)

8460 DIFFERENTIAL SUBLIMATION RATES OF LIGHT AND TRITIUM-LABELLED WATER. R. Moore and E. R. Buskirk (National Inst. of Arthritis and Metabolic Diseases, Bethesda, Md.). Nature, 189: 149-51(Jan. 14, 1961).

A procedure is described for measuring total body water which depends on the liquid scintillation counting of samples of H^3-labeled plasma following vacuum sublimation. Since sublimation to virtual dryness requires one or more hours, an effort was made to shorten the collection period. Results are reported from a study of the effects of the glassware

used for sublimation on the rate of H^3 enrichment of the samples. Results are compared with data on water. Results show that errors in the sublimation procedure are minimized by removing as much water as possible from the sample of biological fluid before it is subjected to the sublimation procedure. (C.H.)

8461 IMPLICATION OF CHROMOSOME STRUCTURE AND REPLICATION ON HAZARD OF TRITIATED THYMIDINE AND THE INTERPRETATION OF DATA ON CELL PROLIFERATION. Eugene P. Cronkite, Samuel W. Greenhouse, George Brecher, and Victor P. Bond (Brookhaven National Lab., Upton, N. Y.). Nature, 189: 153-4(Jan. 14, 1961).

Labeling of chromosomal desoxyribonucleic acid (DNA) with H^3-labeled thymidine (H^3TDR) demands consideration of the probabilities of long term retention of the label and damage to somatic and genetic cells. These are important for the interpretation of results and for consideration of hazards associated with the use of tritiated thymidine in human beings. The model proposed by Taylor, Woods, and Hughes permits prediction of the persistence of the label. The model is based on autoradiographic observations on plant chromosomes labeled with H^3TDR during replication. In this model each chromosome is considered to consist of two halves (chromatids), both of which replicate. If H^3TDR is available during DNA synthesis for a finite period, both half-chromosomes will be labeled in their newly formed replicas. On division, all chromosomes of the daughter cells will contain the label in the newly replicated chromatid. Subsequent DNA synthesis proceeds without further availability of H^3TDR, and newly formed replicas of both labeled and unlabeled chromatids will be unlabeled. In the daughter cells of the second division, on the average half the chromosomes will be labeled, each composed of one labeled and one unlabeled chromatid. After each subsequent division the number of labeled chromosomes per cell will be halved as the originally labeled chromatids become distributed among twice the number of cells. When the synchronously dividing progeny of a labeled cell first exceeds the chromosomal number, the fraction of labeled cells will begin to diminish, since an increasing number of cells will contain a single-labeled chromatid which cannot subdivide, but must go to one daughter cell, leaving the other totally unlabeled. The extent of crossing-over in somatic and genetic cells of man is not known, but it is unlikely to approach a random distribution, as would be expected of exchangeability on a molecular level. Discrete distributions were computed for the human chromosome number 46 and are represented. It has not been established that the model proposed by Taylor, Woods, and Hughes pertains to mammalian chromosomes. It is now under study in tissue culture systems of human cells. If the expected agreement with the Taylor-Woods-Hughes model is confirmed, it will have a direct bearing on the interpretation of data in the study of cell proliferation, and the somatic and genetic hazard of H^3TDR in long-term work. (auth)

8462 QUANTITATIVE CYTOCHEMISTRY USING DIRECTLY APPLIED RADIOACTIVE REAGENTS. E. A. Barnard and J. Marbrook (King's Coll., London). Nature, 189: 412-13(Feb. 4, 1961).

Applications of radioactive isotopes as tracers in cytochemical reactions applied directly to the localization of substances in tissue specimens are discussed. An example is described in which frog red cells were exposed to acetic anhydride labeled with tritium and the amount of isotope bound per cell at various times during the reaction period determined by means of radioautograms. Advantages of the method are discussed. (C.H.)

8463 THEORETICAL COMPARISON OF IODINE-124 AND IODINE-131 THYROID DOSIMETRY. C. M. E. Matthews and B. A. Tucker (Hammersmith Hospital, London). Phys. in Med. Biol., 5: 245-53(Jan. 1961).

The ratio, R, of millicuries of I^{124} to millicuries of I^{131} to deliver the same dose, in rads, to the rat thyroid was calculated, and the effects of variations in the size and shape of the gland and the biological half life were demonstrated. The geometrical factors for a cylindrical model were calculated by a modification of the method of Bush (1949). The gain factor, F, the ratio of the experimental to the theoretical values of R, is discussed in the light of the greater uniformity in dose distribution from I^{124} compared to I^{131}. (auth)

8464 THE USE OF RADIOACTIVE GOLD PREPARATIONS (^{198}Au) IN ONCOLOGY. A. F. Leshchinskii (Odessa Pharmaceutical Inst.). Problems of Oncol. (U.S.S.R.) (English Translation), 6: 760-73 (1960).

A review of the literature shows that a new method of internal radiotherapy has been developed which is based on the physical-chemical properties, the range of radiation, and the pharmacological properties of radioactive gold preparations. This method is of certain value in some cases and has its own indications and contraindications. It is of particular importance that radioactive gold can be injected in cases of disseminated metastases accompanied by exudates in which no therapeutic effect can be achieved with existing methods. The possible combined use of Au^{198} and other methods of treatment of malignant neoplasms seems to be promising. The methods of application of radioactive gold require further improvement aiming at the use of smaller doses of the preparation with a better therapeutic effect. 52 references. (auth)

8465 FURTHER ELECTROPHORETIC RESEARCH ON THE SEROPROTEIC VARIATIONS IN RATS WITH EXPERIMENTAL NEOPLASM TREATED WITH X RAYS. E. Bozzetti and G. Dragoni (Univ., Pavia and Univ., Milan, Italy). Radiobiol. latina, 3: 1-20(Jan.–March 1960). (In Italian)

A number of rats with Walker's carcinoma were given an x-ray treatment intended to slow down the development and the diffusion of the new growth, and the behavior of the seroproteic fractions and of their glucidic and lipidic quota was established by means of electrophoresis in cell and on paper. More than a month after transplantation a marked fall of general conditions was seen and the electrophoretic findings were quite abnormal due to the extreme decrease of albumin and to an increase of the P.A.S. and sudan-positive components which migrate near albumin; as a matter of fact, in the majority of cases a marked increase was seen of α 1 fractions whereas in other cases the formation of a prealbuminic component was shown. (auth)

8466 INVESTIGATION ON THE POSSIBLE "GONAD DOSE" RECEIVED BY THE POPULATION OF ROME AS A RESULT OF THE USE OF X RAYS IN MEDICAL DIAGNOSIS. C. Biagini, M. Barilla, A. Montanara, G. Messe, A. Paglicci, and M. Pisapia (Univ., Rome). Radiol. med., 46: 757-83(Aug. 1960). (In Italian)

The results of a study made on the Roman population to evaluate the doses that in diagnostic use of x rays have genetic significance for the gonads are presented. The summary of the data was made by a direct method and an indirect method. The limits of validity of the data are discussed separately with respect to the doses, the frequency of examination, the age of the persons exposed, and the total combined error. A total evaluation of 44 ± 36 mrem/yr was made. This value, by taking account of the fact that the in-

quiry was limited to a single city, should be considered the lowest in the literature. (tr-auth)

8467 ESTIMATION OF TOTAL BODY FAT FROM POTASSIUM-40 CONTENT. Gilbert B. Forbes, James Gallup, and John B. Hursh (Univ. of Rochester, N. Y.). Science, 133: 101-2(Jan. 13, 1961).

On the assumption that the potassium content of the lean body mass is constant, it should be possible to estimate fat content in living man from a measurement of potassium-40 activity in the whole-body scintillation counter. A series of such measurements on children and young adults shows good correlations with skin-fold thickness and weight/height ratio as indices of fatness. (auth)

8468 THE EFFECT OF AN ORGAN EXTRACT INCREASING THE CELL RESPIRATION ON THE MOUSE SARCOMA S 180 UNDER RADIATION TREATMENT IN PARATUMORAL AND INTRAMUSCULAR INJECTION. Gunther Barth, Herbert Graebner, and Hans Strössenreuther (Medizinische Universitätsklinik, Erlangen, Ger. and Universität, Giessen, Ger.). Strahlentherapie, 113: 584-94(Dec. 1960). (In German)

Examinations on 300 white mice showed that the results of the radiation therapy can be clearly bettered through the treatment of the tumor-bed, or of the whole organism with an organ extract (solcoseryl) which increases the cell respiration. This means that the radiation reaction does not depend solely on the direct action upon the tumor, but also on the biological reaction of the tumor-bed and of the whole organism. (auth)

8469 PHYSICAL COMPARISON OF THERAPY WITH ENERGETIC ELECTRONS AND ULTRAHARD X RADIATION. Rolf Wideröe (Universität, Zürich). Strahlentherapie, 114: 55-62(Jan. 1961). (In German)

An examination shows, that Schittenhelms computations on specific integral doses contain in part quite inexact approximations, in part are based on faulty assumptions, so that further comparisons with other works are superfluous. The integral doses for electron radiations were examined and exact values stated. Finally statements about the distribution of intensity in inhomogeneous bodies were reported. (auth)

8470 RADIATION RESEARCH IN THE LIFE SCIENCES. CURRENT PROJECTS IN THE UNITED STATES AND THROUGHOUT THE WORLD. INFORMATION ON THE MAGNITUDE, ORGANIZATION, AND DISTRIBUTION OF PROGRAMS. (United States. Senate. Committee on Government Operations). Nov. 28, 1960. 176p. $0.55 (GPO).

The magnitude, organization, and distribution of worldwide efforts in radiation research in the life sciences are summarized. Data are included on research projects in the fields of radiation biology; radiation genetics; environmental radiation; radiation toxicology; radiation protection; agricultural research; medical research and applications; radiation detection and measurement; and education, training, and information. Emphasis is placed on procedures, organization, magnitude, and coordination of research activities. An attempt is made to establish the extent of coordination of knowledge as to current research within, among, and between government agencies; government agencies and private, foreign, and domestic research sources; the U. S. Government and foreign governments; various governments and intergovernmental organizations; and among intergovernmental organizations. The cumulated information will serve as a baseline on the over-all magnitude and organization throughout the nations of current radiation research in the life sciences. It is concluded that the AEC and all other interested sources, including the Department of State, should press unrelentingly toward resolving problems of communication, information, and planning in international radiation research. (C.H.)

Biochemistry, Nutrition, and Toxicology

8471 (ACRH-14(p.50-7)) THE LOCALIZATION OF OCTOIODOFLUORESCEIN-I^{131} IN MOUSE BRAIN TUMORS. E. C. Tocus and G. T. Okita (Argonne Cancer Research Hospital, Chicago).

The exact location and extent of brain tumors are often difficult to define. With the advent of radioactive tracer techniques, nontraumatic methods have been developed which use radioactive compounds having an affinity for tumor tissue. The efficacy of I^{131}-labeled octoiodofluorescein (OIF) in localizing brain tumors in mice was studied. This compound was selected because diiodofluorescein, which is an analogue of OIF, is known to localize in tumors. Since OIF is 76% iodine by weight and opaque to x rays, its radio-opaque properties were also studied with a view to its use in cerebral radiography. As no previous biological data on this compound have been published, its toxicity, distribution, excretion, and staining properties were investigated. Data are tabulated. The localization of I^{131}-labeled OIF in brain tumors as demonstrated by a concentration ratio of between 3.15 to 32.8 indicates that OIF-I^{131} may prove to be a suitable agent for localizing brain tumors in humans. (auth)

8472 (ANL-6199(p.16-20)) MICROSCOPIC METABOLISM OF Ra^{226} IN CANINE BONE. PART II. R. E. Rowland.

A study has been made of the distribution of radium in bones of a dog at two widely different times in order to estimate the loss of activity from bone by processes other than direct resorption. A 15-kg mongrel dog, one or two years of age, was given equal intravenous injections of $Ra^{226}Cl_2$ once a week for a period of eight weeks. Four weeks after the last injection the right humerus and radius-ulna were removed by amputation. The dog was sacrificed 353 days later, and the remaining bones were prepared for analysis. It was clearly demonstrated that a loss of radium occurs from both hot spots and the diffuse distribution in canine bone occurs at rates not greatly dissimilar. These losses, which take place by a mechanism we call long-term exchange, are in substantial agreement with the measured loss of Ca^{45} from the diffuse component, as previously reported. These findings, therefore, provide further evidence that in the long-term exchange process in canine bone, both radium and calcium behave with remarkable similarity. Since the measured fractional loss from both hot spots and the diffuse is close to that prevailing in the entire skeleton, it would appear that within the observational period, loss of activity by resorption did not play a dominant role in the removal of radium from the adult dog. (auth)

8473 (ANL-6199(p.68-70)) ESTIMATION OF RADIUM BODY CONTENT OF EXPOSED HUMANS FROM THE ACTIVITY OF EXTRACTED TEETH. Charles E. Miller and J. B. Corcoran.

The uncertainty in the estimate of the total body content of radium in the human skeleton by extrapolation of the radium/calcium ratio present in teeth was investigated in a number of exposed individuals whose total body contents of

radium were measured with the Human Spectrometer and whose teeth were available for study. Data are tabulated. It was concluded that teeth alone should not be used to determine total body content of radium in humans acutely exposed when specimens of bone are available. Data from teeth should be used only within limits if no more suitable material is available. The body content calculated from teeth will possibly fall within a factor or two of the correct value if the teeth which are analyzed had already completed growth at the time the radium was acquired. Since radon retention may vary substantially and add to the uncertainty, assumptions as to its value should be avoided. (auth)

8474 (ANL-6199(p.88-93)) Ra^{226} IN BOVINE BONES AND TEETH. Elvira R. Di Ferrante.

Twenty-five bovine jaw bones with teeth were analyzed for Ra^{226} content of bones and teeth. Data are tabulated. Ratios of Ra^{226} concentrations in bone and teeth were calculated. (C.H.)

8475 (ANL-6199(p.94-106)) SOME DETERMINATIONS OF THE RaD AND RaF CONCENTRATIONS IN HUMAN BONE. Richard B. Holtzman.

Surgical bone and tooth specimens were analyzed for Ra^{226}, Pb^{210}, and Po^{210}. Data are tabulated. An attempt was made to determine whether or not any correlation exists between Pb^{210} and Ra^{226} concentrations in various types of bone. (C.H.)

8476 (ANL-6199(p.107-111)) APPENDIX I. ANALYSIS OF TISSUE SAMPLES FOR POLONIUM-210 (RaF). Richard B. Holtzman.

A procedure is described for the radiometric analysis of tissue samples for Po^{210}. (C.H.)

8477 (ANL-6199(p.112-14)) APPENDIX II. THE DISTRIBUTION OF THE RaD CONCENTRATION AS A FUNCTION OF BONE TYPE IN THREE UNEXPOSED SUBJECTS. Richard B. Holtzman.

Data are tabulated on the distribution of Ra^{226} and Pb^{210} in human bones. Results indicate that, due to variations in metabolism of various bones and in intake rates with time, the Pb^{210} content of the whole body cannot be established from measurements on teeth or single bones. (C.H.)

8478 (CF-59-6-107) A FEASIBILITY REPORT ON A METHOD OF DIRECT TOTAL BODY MEASUREMENT OF ENRICHED URANIUM IN MAN. Fred W. Sanders (Oak Ridge National Lab., Tenn.). Aug. 7, 1959. 30p. Contract W-7405-eng-26.

In a proposed method for measuring enriched uranium body burden, part of the U^{235} would be fissioned by neutron irradiation and the fission neutrons counted. The fission neutron count rate should be proportional to the amount of enriched uranium present in the body. Irradiating neutrons should be of an energy such that the whole body volume would receive a uniform irradiation of thermal neutrons. To get maximum counting efficiency, the fission neutrons could be moderated to thermal energies and counted by means of BF_3 tubes. The moderator for the fission neutrons would be separated from the irradiating neutrons by a suitable shield. A feasibility study of this method was performed. Mice were selected as the animal for which the first model would be designed because uniform whole body irradiation by thermal neutrons is easiest for small-bodied animals. It was concluded that although the proposed method of measuring human body burden of enriched uranium would not significantly increase the exposure of the person being examined, the method is not feasible because it lacks the required sensitivity. Since the device was not sufficiently sensitive for the simplest case, a small animal, it seems very unlikely that a device of this type could be successfully employed for the measurement of the enriched uranium body burden of humans. (auth)

8479 (IEA-14) DETERMINATION OF Cr-51 AND Fe-59 CONTAINED IN SAMPLES OF BIOLOGICAL MATERIALS—STUDY OF SOME TECHNIQUES. (Determinação de Cr-51 e Fe-59 Presentes em Amostras de Materiais Biologicos—Estudo de Algumas Técnicas). R. R. Pieroni, V. Maspes, and S. Bruni Herdade (São Paulo, Brazil. Universidade. Instituto de Energia Atômica). 1960. 26p.

Four techniques are given and evaluated for determining Cr^{51} and Fe^{59} simultaneously in biological materials: the first is measurement of radioactive decay rate; the second involves use of a lead absorber and a scintillation detector because of the difference in γ energies of the two isotopes; a scintillation counter with a pulse analyzer was used for the third; and the fourth technique employed a Henuator (discriminator). It is concluded that the third method gives the best results, but the equipment is expensive and requires technical maintenance. The pulse analyzer can be replaced by the attenuator or an absorber. The decay method gives rise to large errors and is time-consuming. (T.R.H.)

8480 (TID-11355) ASSIMILATION OF RADIOACTIVE PHOSPHORUS IN HYALELLA AZTECA (thesis). Robert Frederick Johnson (Iowa State Univ. of Science and Technology, Ames). 1960. 38p. Contract AT(11-1)-59:11.

Results are reported from a study of methods for assaying the role of microcrustaceans in the transfer of solar energy. Hyalella azteca, commonly called scuds, were selected for study as representatives of an intermediate link in the food chain from production of organic matter by plants to utilization by fish. Phosphorus-32 was selected as a labeling agent for controlled feeding experiments. Procedures are described. An analysis of variance showed that the P^{32} uptake by H. azteca from bacteria and from concentrations of algae is additive and independent. Factors that affect the feeding and rates of assimilation of phosphorus by H. azteca are discussed. (C.H.)

8481 (TID-11422(Sect.1)) A STUDY ON THE DETERMINATION OF HEAVY WATER IN PLASMA OR URINE. O. H. Gaebler and Harold C. Choitz (Henry Ford Hospital. Edsel B. Ford Inst. for Medical Research, Detroit). Sect. 1 of COMPARATIVE METABOLIC EFFECTS OF CERTAIN HORMONES AND X-IRRADIATION. 14p.

A technique is described for determining excess deuterium oxide in plasma or urine, by directly measuring 19:18 ratios in vapor from these fluids with a mass spectrometer of suitable design. Although the 19:18 ratio for water varied with sample size and other experimental conditions, the increment in ratio per unit concentration of added D_2O remained quite uniform. A virtually linear relationship between the increment in ratio and the concentration of added D_2O also facilitated checking the calibration. The time required for flushing out deuterium, when a pyrex inlet system was used, could be minimized by carrying out both the calibrations and the analyses in triplicate, without intermediate flushing, but with adherence to a strict time schedule. Results calculated from increments in ratio for the second and third samples of vapor rarely differed from their average value by more than ±0.8%. (auth)

8482 (AEC-tr-4361) BONDING BETWEEN ELECTROCONDUCTIVITY AND ENERGY MIGRATION IN PROTEIN AND OTHER ORGANIC MOLECULES. N. V. Ril'. Translated by Lydia Venters (Argonne National Lab., Ill.) from Zhur. Fiz. Khim., 29: No. 9, 1537-48(1955). Dec. 1960. 16p.

Experiments are described which relate proton mobility in protein to proton mobility in ice. (T.R.H.)

8483 (AEC-tr-4428) ON THE TOXICOLOGY OF CERTAIN SUBSTANCES USED IN THE PRODUCTION OF SYNTHETIC POLYMERS. M. L. Rylova. Translated from Gigiena i Sanit., 25: No. 8, 74-9 (Aug. 1960). 7p.

Results are presented from a study on the toxicology of certain substances used in the production of synthetic plastic materials and resins. Experiments on mice showed chronic poisoning by exposure to vapors of styrene and its derivatives and allergic ailments of the skin caused by certain monomers and also by individual polymer compounds. Data are included on the toxic effects of styrene and its derivatives; aldehydes of the aliphatic series; complex esters of vinyl alcohol; certain monomers used in the preparation of polysulfide rubbers; 1,2,3-trichloropropane; certain unsaturated acetylenic hydrocarbons; vinylidene chloride; alkyl chlorosilanes; and a number of resinous mixtures. (C.H.)

8484 IN VITRO I^{131} UPTAKE BY SALIVARY GLANDS, STOMACH AND PLACENTA. M. Maqsood and E. P. Reineke (Michigan State Univ., East Lansing). Am. J. Physiol., 199: 1045-7 (Dec. 1960).

Slices of various tissues of the rat were incubated at 37°C for 6 hr in 2 ml of medium containing 0.3 μc carrier-free I^{131}. I^{131} concentration significantly above that of the medium, and of boiled tissues, was observed in salivary glands and stomach, but not in liver or placenta. I^{131} uptake by parotid was significantly higher than that of submaxillary and sublingual tissues. Uptake by tissues from the cardiac portion of the stomach was significantly greater than in those from the pyloric portion. Concentration of I^{131} by salivary glands and stomach slices was reduced by the addition of thiouracil (0.02 mg/ml), KSCN (0.1 mg/ml), or NaCN (0.1 mg/ml), but it was not affected by the addition of TSH (100 μg/ml) to the medium. None of these additives influenced the small I^{131} uptake found in liver and placenta. I^{131} uptake by salivary glands and stomach of the mouse, dog, and cow was similar to that in the rat, except that there was less difference between the parotid and submaxillary glands. (auth)

8485 EFFECT OF ALLOXAN-INDUCED DIABETES ON MAGNESIUM METABOLISM IN RABBITS. Jerry K. Aikawa (Univ. of Colorado, Denver). Am. J. Physiol., 199: 1084-6 (Dec. 1960).

In six rabbits external balance studies for magnesium were performed for 11 days after diabetes had been induced by the injection of alloxan. The only significant change observed was a decrease in mean body weight. The exchangeable magnesium content, determined with Mg^{28}, also showed a significant decrease. In another group of 16 rabbits, the relative radioactivity of Mg^{28} in muscle, skin, appendix, lung, liver, heart, kidney, and bone was not altered by the administration of alloxan to half the group. The magnesium content of the skin was decreased, and that of the bone increased. Alloxan diabetes is associated with changes in the dynamics of magnesium metabolism which may not be demonstrable by the external balance technique. (auth)

8486 RARE-EARTH NITRATE AND OXIDE. G. S. Melville, Jr. (Brooks AFB, Texas) and R. W. Riess. Arch. Environmental Health, 2: No. 2, 178-84(Feb. 1961).

Rare-earth nitrate and oxide salts were given to rats by intraperitoneal injection and by subcutaneous implantation. Groups of these animals were given 800 r of γ rays in addition to the chemicals. No mortalities occurred among the nonirradiated-treated rats. Radiation plus treatment caused mortality in rats which had received either compound intraperitoneally. Rare-earth nitrate was more effective than rare-earth oxide. Rare-earth nitrate was more effective in peanut oil than in water. Rare-earth nitrate was more damaging than rare-earth oxide when implanted by subcutaneous injection. The nitrate salt caused necrotic lesions, whereas only nodules resulted from treatment with the oxide. (auth)

8487 AN EVALUATION OF THE COBALT-60 VITAMIN B_{12} ABSORPTION TEST. I. H. Holmes and R. Edward Bell (Univ. of Alberta Hospital, [Edmonton]). Can. Med. Assoc. J., 84: No. 2, 79-83(Jan. 14, 1961).

A consecutive series of 150 Co^{60}-labelled vitamin B_{12} absorption tests performed at the University of Alberta Hospital was reviewed. Normal individuals and subjects who had an anemia other than pernicious anemia excreted more than 6% of the oral dose in 24 hr. In pernicious anemia the excretion of Co^{60}-labelled vitamin B_{12} was 2.5% or less. The addition of intrinsic factor increased these values to 6% or higher. The test probably has its most important use in differentiating patients with true pernicious anemia from those who have had an incorrect diagnosis of pernicious anemia and are being or have been treated for this condition. The test has found an increasing use in the differentiation of subacute combined degeneration of the spinal cord from other neurological conditions. Patients with malabsorption states generally have absorption values below 6% but by no means consistently. Addition of intrinsic factor does not increase the absorption. Our results bear out the contention of Dunn and coworkers that where renal impairment exists, as evidenced by elevated blood urea nitrogen, low Co^{60}-labelled vitamin B_{12} absorption values are found in 24-hr urine collections. (auth)

8488 A CHEMICAL VIEW OF OSTEOCLASIS BASED ON STUDIES WITH YTTRIUM. W. F. Neuman, B. J. Mulryan, and G. R. Martin (Univ. of Rochester, N. Y.). Clin. Orthopaedics, No. 17, 124-34(1960).

A study was made of the mechanisms underlying the skeletal deposition of yttrium, using radioactive yttrium. Experiments were made using a synthetic hydroxyapatite and bits of fresh human cortical bone. Data are included on the disappearance of yttrium from solutions as a function of time, the exchange-absorption of yttrium by hydroxyapatite crystals, the effect of calcium concentration on the course of yttrium exchange, and the effect of pH and citrate on the ultrafilterability of yttrium from blood serum. The role of the parathyroid gland in osteoclasis is discussed. A scheme is presented which postulates that parathyroid hormone causes cells in bone to produce citric acid, which in turn causes an increased solubility of bone mineral locally. It is concluded that the processes of bone resorption are still not fully understood. (C.H.)

8489 STUDY OF ^{131}I METABOLISM IN NEW-BORN RATS BY ANATOMICAL AUTORADIOGRAPHY AT −195°C. Pierre Pellerin and Marie-Renée Siroux (Commissariat à l'Énergie Atomique, Paris). Compt. rend., 249: 2125-7 (Nov. 16, 1959). (In French) (CEA-1619).

Iodine-131 metabolism was studied in rats from 30 sec to 14 days after birth by the anatomical autoradiography method at liquid nitrogen temperature. The established phases were confirmed, but in addition a very early and intense cutaneous fixation, as well as heavy gastric, salivary, and lacrymal secretions of iodine was observed. (auth)

8490 THE ACCUMULATION OF U−UX_1 BY NITROGEN-FIXING MICROORGANISMS OF THE BLACK SEA. L. P. Pshenin. Doklady Akad. Nauk, S.S.S.R., 133: 1448-50(Aug. 21, 1960). (In Russian)

Sixteen cultures of azotobacteria from the Black Sea, 12 strains of bacilli which fixed 0.64 to 8.61 mg nitrogen per gram of glucose and 4 yeast cultures of the genus Torulopsis and Rhodotorula which fixed 0.12 to 1.06 mg nitrogen per gram of glucose, were grown in a medium containing 1 to 2×10^{-6} g $U\text{-}UX_1$ per gram (the natural concentration of uranium in sea water). The radioautographic results showed that the yeast of the genus Torulopsis and of strain 1 Rhodotorula were the most active in accumulating uranium. Azotobacter chroococcum, A. agile, and the bacilli displayed much weaker radioautograms. The other cultures had no visible effect on the photofilm even after an exposure of 6 months. (TTT)

8491 THE METABOLISM OF INDIUM AFTER ADMINISTRATION OF A SINGLE DOSE TO THE RAT BY INTRATRACHEAL, SUBCUTANEOUS, INTRAMUSCULAR AND ORAL INJECTION. G. A. Smith, R. G. Thomas, and J. K. Scott (Univ. of Rochester, N. Y.). Health Phys., 4: 101-8(Dec. 1960).

Distribution and excretion of indium after four routes of administration were studied by counting the γ activity of tissues from rats injected with tracer amounts of indium-114m. In 4 days over half the administered dose was absorbed from the injection sites in all but the oral route where absorption was in the order of 0.5% of the administered dose. A general distribution of the isotope was seen after all routes studied, with kidney, spleen, liver, and salivary glands containing higher concentrations. Pelt, skeleton, and muscle contained the largest absolute amounts of indium, and of these three skeleton had the highest concentration. Excretion of indium, with the exception of the oral route, was essentially independent of route of administration, occurring with an early rapid phase and a long slow phase which approximated a single exponential after about 20 days. At 30 days after administration 33 to 40% of the administered dose had been eliminated from the body in urine and feces. Urinary excretion data after all but the oral route were so similar that they were treated statistically as one population and may form the basis for a reliable bio-assay method utilizing analysis of daily urine samples. (auth)

8492 SOME DYNAMIC ASPECTS OF THE THYROID FUNCTION STUDIED BY THE ISOTOPIC EQUILIBRIUM METHOD. Cl. Simon and F. Morel (Commissariat à l'Énergie Atomique, Saclay, France). Intern. J. Appl. Radiation and Isotopes, 8: 35-45(1960). (In French) (CEA-1740).

The isotopic equilibrium method, used to examine the functioning of the thyroid in vivo, is based on the principle of replacement from a pool in a dynamic stationary state. The kinetics of the replacement process can be observed, and the secretion of thyroid hormone can be qualitatively measured. The method has the advantage of replacing chemical determinations of iodine in the thyroid and the plasma by simple measurement of radioactivity in conditions of isotopic equilibrium. In rats fed with either 5 or 50 μg of iodine per day, the results show that iodouremia is proportional to the intake in food; that the hormonal iodine concentration in the plasma is 0.02 and 0.033 μg/ml, respectively; and that the thyroid secretes 1 and 1.6 μg of hormonal iodine per day, respectively. Seasonal variations are observable. On the kinetic level, simultaneous study of the thyroid iodine and of the organic iodine in the plasma reveals a functional heterogeneity of the thyroid in animals receiving 50 μg of iodine per day. (auth)

8493 CONCENTRATION OF LABELED TRI-IODOTHYRONINE AND RADIOACTIVE ALBUMIN IN HUMAN CEREBRAL NEOPLASMS. Robert L. Bell (State Univ. Medical Center, New York and Kings County Hospital Center, Brooklyn). J. Nuclear Med., 1: 180-5(July 1960).

The data thus far collected indicate that 24 hr after the intravenous injection of 500 μc of radioactive serum albumin there is a significant differential between its uptake by brain tumor and normal brain, especially in the more malignant gliomas. Similar studies showed that there is not a selective uptake of triiodothyronine by brain tumor tissue. The problem remains of obtaining materials which preferentially cross the blood-brain barrier in a wider variety of tumors. (auth)

8494 THE CLEARANCE OF Ag^{111} FROM PLASMA AND LIVER OF CIRRHOTIC AND NON-CIRRHOTIC PATIENTS. Wm. A. Reilly, Kenneth G. Scott, and G. L. Searles (San Francisco Veterans' Administration Hospital and Univ. of California School of Medicine, San Francisco). J. Nuclear Med., 1: 191-4(July 1960).

The metabolism of radiosilver was studied in the human. It was found that radiosilver incubated with autogenous plasma and introduced into the subject by intravenous injection will be removed from the plasma principally by the liver. The rate of this removal is less in the cirrhotic subject than in the noncirrhotic. Silver accumulated in the liver is excreted from that organ with a normal half-time value of approximately 11 days; this function is also retarded in the cirrhotic liver, where the half-time value is approximately 20 days. (auth)

8495 BIOLOGICAL CONTROL OF Cr^{51} O_4Na_2: EFFECTS OF TRIVALENT CHROMIUM. Y. Cohen and J. Ingrand (Commissariat à l'Énergie Atomique, Paris). Minerva nucleare, 4: 110-13(Apr. 1960). (In French) (CEA-1722).

A biological control of Cr^{51} solutions, used as tracers in biology and medicine, is necessary because of the changes which occur in such solutions on account of the radioactivity. The factor which makes the use of biological tests necessary is considered. During red blood cell labeling, a number of partially obscure factors are involved, including the presence of trivalent chromium which, in spite of its removal from the radiochromate solutions, tends to form during the storage of these solutions and seems to evolve from a soluble to an insoluble form. The biological tests used take into account this evolution and insure control of the labeling properties of Cr^{51}, namely, its in vitro affinity for red blood cells and its in vivo stability. (auth)

8496 GLUTAMIC ACID METABOLISM IN BRAIN AND LIVER DURING INFUSION WITH AMMONIA LABELLED WITH NITROGEN-15. G. Takagaki, S. Berl, D. D. Clarke, D. P. Purpura, and H. Waelsch (New York State Psychiatric Inst., and Columbia Univ., New York). Nature, 189: 326(Jan. 28, 1961).

Recent results of in vivo experiments using glutamic acid labeled with C^{14} were consistent with the hypothesis that the amidation of the administered amino-acid to glutamine represents a metabolic event occurring in a tissue or cellular compartment. Since glutamic acid and glutamine syntheses in the central nervous system are the two known processes by which ammonia enters organic linkage, it appeared of great interest to approach the question of setting into compartments the metabolism of glutamic acid and its derivatives with the aid of ammonia labeled with N^{15}. N^{15}-ammonium acetate was infused into the carotid artery of cats over a period of 8 to 85 min with simultaneous electroencephalographic and electrocardiographic tracings. The experiments were terminated by exsanguination of the

animal, the blood was collected, brain and liver excised and frozen, and the level of glutamic acid and its metabolic derivatives determined in the tissue samples, as well as the concentration of N^{15} in the amino or amide groups, respectively, of these compounds. The results of a typical experiment of 25-min duration are tabulated. Observations on metabolic reactions in brain and liver are discussed. (C.H.)

8497 INCORPORATION OF TRITIATED THYMIDINE INTO DNA AFTER ORAL ADMINISTRATION. Joseph R. Rubini, S. Keller, L. Wood, and Eugene P. Cronkite (Veterans Administration Hospital, Dallas; Univ. of Texas, Dallas; and Brookhaven National Lab., Upton, N. Y.). Proc. Soc. Exptl. Biol. Med., 106: 49-52(Jan. 1961). (BNL-5005)

Parenteral tritiated thymidine (H^3TDR) was administered via a stomach tube to rats, mice, and guinea pigs. Some ingested H^3TDR was absorbed and labeled proliferating cells of gastrointestinal mucosa as early as 2 hr after ingestion in guinea pigs. Labeling of diverse tissues, including proliferative cells of the testes was seen in rats and mice 7½ hr after ingestion. Some of the H^3TDR was degraded to tritiated water and small amounts of nonvolatile H^3 activity were excreted in the urine. The significance of absorption of H^3TDR through intestinal mucosa is discussed as related to potential hazard. (auth)

8498 EXCRETION OF URINARY N-C^{14}-METHYL MORPHINE AND PULMONARY $C^{14}O_2$ IN THE MONKEY AND DOG AFTER SUBCUTANEOUS INJECTION OF THE LABELLED DRUG. L. B. Mellett and L. A. Woods (Univ. of Michigan, Ann Arbor). Proc. Soc. Exptl. Biol. Med., 106: 221-3(Jan. 1961).

The results of urinary excretion and $C^{14}O_2$ elimination experiments in dogs and monkeys receiving 2.0 mg/kg of N-C^{14}-methyl morphine, subcutaneously, were as follows: dogs excreted 13 to 15% of the total dose as free morphine and 48 to 52% as conjugated morphine and about 0.2% as exhaled $C^{14}O_2$. Monkeys excreted 6 to 14% as free morphine and 55 to 71% as conjugated morphine and about 1% as exhaled $C^{14}O_2$. (auth)

Fallout and Ecology

8499 (HASL-105) FALLOUT PROGRAM. Quarterly Summary Report [for] September 1, 1960–December 1, 1960. Edward P. Hardy, Jr., Joseph Rivera, and Robert Frankel (New York Operations Office. Health and Safety Lab., AEC). Jan. 9, 1961. 188p.

Current information coming from the HASL Fall-out Program from the U. S. Naval Research Laboratory is included. Data on radionuclide levels in deposited fall-out, and in air, water, wheat, bread, milk, and other foods are included. Interpretive reports on radioactivity in the atmosphere, on Sr^{90} levels in wheat and milling products, and on analytical errors in the strontium program are included. Finally, a bibliography of recent literature is presented. (auth)

8500 (TID-11033) SYMPOSIUM ON RADIOISOTOPES AND BONE UPTAKE OF Ca^{45} AND CARBON 14-LABELED PROLINE BY LIVING AND DEAD BONE. Presented at meeting of CIOMS, Aug. 29–Sept. 2, 1960, at Princeton, N. J. (Presbyterian–St. Luke's Hospital, Chicago). 61p. Contract No. AT(11-1)-507.

Data are presented from studies on the effect of Sr^{90} on the mobilization of stable strontium from the skeleton of rats; the effects of diuresis, parathormone, and cortisone on the mobilization of Sr^{90} from the skeleton of rats; and radioisotope studies of generalized skeletal disorders and vitamin-D-resistant rickets. (C.H.)

8501 (TID-11114) INVESTIGATIONS OF PATHWAYS IN PLANT METABOLISM. Progress Report for the Period November 20, 1959–November 8, 1960. A. A. Benson (Pennsylvania State Univ., University Park). Nov. 5, 1960. 9p. Contract AT(30-1)-1876.

Neutron activation chromatographic analysis has been used widely for quantitative estimation of phosphatides in plant and animal tissues. Methods have been extended to include neutron activation of bromine-containing derivatives of organic compounds of metabolic significance. Sugars, carboxylic acids, and unsaturated fatty acids have been converted to derivatives containing bromine. Chromatography and neutron activation to give Br^{80} allows qualitative and quantitative analysis. The plant sulfolipid is recognized as a sulfoglycosyl diglyceride. This chloroplast lipid, whose concentration approximates that of chlorophyll and exceeds that of most phosphatides, contains a sulfosugar. It is rapidly synthesized from either $C^{14}O_2$ or from $S^{35}O_4^=$. Further isolation of sulfoglycosyl glycerol has been carried out and the sulfosugar has been isolated by anion exchange resin chromatography. The formation of the $-CH_2-SO_3H$ structure constitutes an important aspect of carbohydrate metabolism in plants. The chemistry of aliphatic hydroxy sulfonic acids has received little attention. This study has been restricted by lack of fundamental chemical information. It has required synthesis of labeled sulfolactaldehyde and sulfoacetaldehyde. It is apparent that these compounds are metabolized by plant cells. The physical and chemical properties of this family of compounds are being studied. Scintillation counting methods applicable in radiochromatographic studies were developed further. Plastic phosphors are used for counting C^{14} in chromatographic spots and in flowing effluents from exchange resin columns. The lipids of mitochondria were examined chromatographically. Plant mitochondria have phosphatidyl glycerol as the predominant lipid while chloroplasts contain much more of the glactosyl diglycerides. The characteristic lipid components of mitochondria were identified in pure monkey heart cell cultures. (auth)

8502 (TID-11156) PHYSIOLOGICAL CROP ECOLOGY USING RADIOISOTOPES. Annual Report for Year June 1, 1960 to February 28, 1961. (Minnesota. Univ., St. Paul. Inst. of Agriculture). Nov. 1960. 64p. Contract AT(11-1)-783.

Investigations were made on the circulation pattern for the translocation of P^{32} in soybean. Application of P^{32} to cotyledons, primary leaves, and the first trifoliate leaf was made at intervals of from 2 to 5 days during the lives of the organs. The subsequent movement of P^{32} was observed. Translocation of P^{32} in adult corn plants was studied in order to find an efficient and safe method of applying P^{32} to corn. Two methods were tried, one using lanolin and one Van Tiegham cells. The latter was found to be the most effective. Studies were continued on the patterns of translocation in pea plants particularly in respect to flowering and fruiting. Studies confirmed earlier work showing that there is a strong direction of movement of material from the bloom node leaf to the fruit at that node. Distribution patterns for C^{14} supplied as $C^{14}O_2$ and for P^{32} were studied for pea. The rate of movement of P^{32} across the epidermis of oats, wheat, and onion was found to be from 50 to 150 cpm per second. Most uniform results were obtained with onion. The movement of P^{32}, Zn^{65}, S^{35}, and Sr^{89} in the mycelium of Rhizoctonia solani was observed. These studies demonstrate conclusively that soil fungi can translocate radioisotopes in vitro. This is part of a study to determine the effectiveness of soil fungi in translocating materials in situ in the soil.

Studies were continued on the exchange of foliarly applied P^{32} between soybeans and its weed competitors. Additional equipment has been installed in the field laboratory at Rosemount. These include the thermocouple network and panel. The records are being taken on solar radiation, precipitation, and wind velocity and direction. The experimental plots involving a 5-crop rotation were established. Field plots for the placement of Sr^{90} were prepared in order to study the uptake and movement of Sr^{90} in soybeans and corn. (auth)

8503 (TID-11698) STUDIES ON MARINE FOOD CHAINS WHICH COULD INTRODUCE RADIOACTIVE MATERIALS TO MAN, AND ANNUAL CHANGES IN CERTAIN NATURAL POPULATIONS. Annual Progress Report, January 15, 1960–January 15, 1961. Ralph W. Dexter (Kent State Univ., Kent, Ohio). 8p. Contract AT(11-1)-411.

An investigation was made of the links in the food chain which could transmit radioactive matter in sea water through food fishes to man. Data are included on the stomach contents of food fishes landed at Gloucester, Massachusetts, during the summer of 1960. Progress is reported in studies to determine any marked changes in certain populations which may be attributed to fall-out radiation. Observations are included on marine communities at Cape Ann, Massachusetts; populations of Anostraca crustacea in Northeastern Ohio and East Central Illinois; a Gastropod population of the Salt Fork River, Illinois; the chimney swift population on the campus of Kent State University; the Japanese beetle population of the Kent-Ravenna area of Portage County, Ohio; and the population of fresh water jellyfish in Crystal Lake, Ohio. A list of publications during the period is included. (C.H.)

8504 (TID-11749) ALGAE: RADIOACTIVITY UPTAKE AND IRRADIATION EFFECTS. A Literature Search. L. L. Smith (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Jan. 31, 1961. 4p.

Twenty-seven references are included on the uptake of radioisotopes by algae and the biological effects of external or internal irradiation of algae. (C.H.)

8505 THE CESIUM–POTASSIUM DISCRIMINATION RATIO. K. G. McNeill and O. A. D. Trojan (Univ. of Toronto). Health Phys., 4: 109-12(Dec. 1960).

An investigation was made of the γ-ray activity of foodstuffs eaten by Toronto residents in the spring of 1959, and a comparison made with the activity of the residents themselves. From this, it is calculated that the cesium–potassium discrimination ratio, $(Cs/K)_{food} : (Cs/K)_{body}$, is 1:3. (auth)

8506 STRONTIUM-90 IN HUMAN PLASMA. G. E. Harrison (Radiobiological Research Unit, Harwell, Berks, Eng.), Alice Sutton, and W. D'A. Maycock. Nature, 189: 324(Jan. 28, 1961).

The average daily dietary intake of Sr^{90} in Britain during 1958 was assessed at about 6 $\mu\mu$c/g calcium. Measurements were made on the Sr^{90} content per gram of calcium in samples of human pooled plasma prepared from whole blood collected between November 1958 and March 1959. The observed concentration of Sr^{90} in plasma was consistent with the calculations for daily dietary intake. (C.H.)

8507 STRONTIUM-90 AND CAESIUM-137 IN GRASS AND MILK IN FINLAND DURING 1959. J. K. Miettinen (Biochemical Inst., Helsinki, Finland), O. Paakkola, R. Näsänen, A. Vuorinen, and D. Merten. Nature, 189: 324-5 (Jan. 28, 1961).

Results are reported from determinations of Sr^{90} and Cs^{137} in samples of grass and milk collected in Finland during 1959. Data are tabulated. Results show that the Sr^{90} and Cs^{137} contents of milk do not differ essentially from that of the milk of other countries with corresponding climatic conditions. The discriminating factor for grass and milk, or the ratio of $\mu\mu$c Sr^{90}/g calcium in milk divided by this ratio for grass, was shown to be about 0.008. The corresponding factor for Cs^{137} was calculated as 0.28. (C.H.)

Radiation Effects on Living Tissues

8508 (A/AC.82/G/L.473) THE SUMMARY OF RESEARCHES IN JAPAN PARTICULARLY RELATED TO THE DOCUMENT A/AC.82/R.87. Koiti Murati, comp. (Rikkyo Univ., Tokyo) and Daigoro Moriwaki, comp. (Tokyo Metropolitan Univ.). May 1960. 27p.

Summaries are presented from studies on the genetic effects of radiation on populations of Drosophila and yeast. A discussion is included of methods for the determination of optimum mutation rate and degree of dominance by the principle of minimum genetic load. (C.H.)

8509 (A/AC.82/G/L.502) THE ROLE OF CELLULAR CYTOPLASMA IN THE DEVELOPMENT OF PRIMARY EFFECT OF RADIATION. Milan Silha (Ceskoslovenska Academie Ved. Biofyzikdine Ustav, Brno). Jan. 16, 1961. 12p.

The role of cellular cytoplasma in the development of primary radiation effects was studied in liver homogenates from normal and irradiated rats. A difference was found in the time necessary for the coagulation of nuclei-free homogenates from irradiated and nonirradiated rats. Since it was assumed that an autolytic process took place in incubated homogenates, measurements were made on proteolytic activity and the amount of phosphorus released during incubation. It was found that 50% more phosphorus was released from liver homogenates from irradiated rats than from nonirradiated animals. Mitochondria were isolated from the homogenates. Coagulation studies indicate that neither nuclei, microsomes, or smaller particles play a substantial part in the coagulation reaction. It is postulated that mitochondria may release a substance that causes the precipitation of protein. (C.H.)

8510 (A/AC.82/G/L.504) CHANGES IN O_2 CONSUMPTION BY RATS DURING IRRADIATION. A. Vacek (Ceskoslovenska Akademie Ved. Biofyzikdine Ustav, Brno). Jan. 16, 1961. 12p.

Oxygen consumption was found to increase in irradiated rats from the first minute of irradiation. Whole-body doses of 10 or 50 r produced a statistically significant increase in oxygen consumption. The rate of increase in oxygen consumption indicates a probable reflex mechanism of the respiratory reaction. Experiments using chordotomy confirmed this assumption and showed that periphery receptors play an important role in the increase of oxygen consumption during irradiation. (C.H.)

8511 (ACRH-14(p.58-67)) THE EFFECT OF IRRADIATION ON NORMAL HEMAGGLUTININS AND BACTERICIDINS OF MICE. L. Kornfeld, C. W. Hammond, and C. P. Miller (Argonne Cancer Research Hospital, Chicago).

Increased susceptibility to bacterial infection is one important result of total-body exposure to a mid-lethal dose of x radiation. In the mouse, microorganisms from the intestinal tract commonly invade the blood stream during the second week postirradiation and give rise to fatal bacteremias. The effect of irradiation on the cellular elements of the mouse's defense mechanism has been well studied, but it is also possible that its humoral elements,

i.e., natural antibodies may be affected. Results are reported from investigations undertaken to find out whether the loss of some antibacterial substance from the blood of the irradiated mouse might contribute to its increased susceptibility to bacterial infection. The effect of irradiation on the natural hemagglutinins in mice and its effect on natural bactericidins were investigated. (auth)

8512 (AF-SAM-60-70) DEVELOPMENT, DOSIMETRY, AND USE OF MICRO-BEAMS OF X-RAYS FOR SIMULATING MICRO-LESIONS PRODUCED IN ANIMAL TISSUES BY HEAVY COSMIC RAY PRIMARIES. William E. Straile and Herman B. Chase (Brown Univ., Providence). Oct. 1960. 10p.

Issued by School of Aviation Medicine, Brooks AFB, Tex.

Three methods are described for the collimation of x-ray beams to produce both circular and elongate micro-beams. The elongate micro-beam was found to be well adapted for biologic experimentation. Elongate micro-beams do not geometrically simulate heavy cosmic-ray primaries, but are more suitable than circular collimated micro-beams for simulating micro-lesions produced in animal tissues. A method of photographic dosimetry was developed for measurements of micro-beams, and studies were made of the geometric dimensions of micro-beams. Data are included on comparative dosimetry of micro- and macro-beams of x rays. Results are reported from a histologic examination of mouse skin 18 days after irradiation with 4000, 6000, or 8000 r using a 150-μ-wide elongate micro-beam of x rays. Results indicate that prolonged hyperplasia of epithelial tissue and the resulting formation of follicular cysts are secondary effects of irradiation, which may not be encountered in micro-lesions produced by heavy cosmic-ray primaries. (C.H.)

8513 (ANL-6199(p.21-35)) POINT-SOURCE BETA IRRADIATION OF BONE. J. Jowsey and R. W. Rowland.

Cell death and tumor induction are two significant responses of bone to the intense local dose delivered by the point sources of β irradiation. The sharp demarcation between the dark staining osteocytes and the empty lacunae was found to correspond to an accumulated dose of the order of 35,000 to 45,000 rads. Actual cell death may have occurred at lower doses, for the change in the histological appearance of a cell may lag in time after its death; but the fact remains that this technique, with lower dose rates, should provide a method of determining the dose required to kill these cells in vivo. In addition, since normal bone growth was evident around control pegs, indicative that the vascular supply was not permanently damaged by the process of inserting the peg, it would then appear that the cell death around radioactive pegs was the result of direct β irradiation, and not disruption of the vascular supply. Since the site of origin of the tumors could not be determined, other than that they seemed to arise from within the irradiated volumes, either the dose delivered to the site or the cells directly involved cannot be determined. It is noteworthy, however, that two tumors were induced within the diaphysis, and none within the metaphysis, although the number of tumors induced is obviously too low to be truly significant. Tumors, when induced in the long bones by means of bone-deposited isotopes, are often found in the metaphyseal region; however, this region is also the site of the largest uptake of these isotopes, even in the adult animal. Thus with such experiments it cannot be determined whether the high tumor incidence in this location is due to an increased sensitivity of the cells in this region or to the increased number of cells that are irradiated here or to the higher radiation dose delivered by the isotope in this region. The point-source technique, by eliminating the inequalities of dose and volume irradiated, may clarify some of the perplexing problems involved in tumor-induction studies and complement studies of partial skeletal irradiation by x rays, which also irradiate adjacent soft tissues with doses comparable to those received by the bone. (auth)

8514 (ANL-6199(p.36-43)) PLUGGED HAVERSIAN CANALS IN A RADIUM CASE. R. E. Rowland.

The plugs in the haversian canals in bone sections of a radium dial painter were studied extensively, and found to be relatively short, with an average length of only 480 microns for the solid plugs and 900 microns for solid and partial plugs. The number of canals plugged in any bone section is relatively constant for the plugs are not contained in a few osteons but appear in almost all of them. Thus it would appear that blood flow must be severely limited, but since the number of interconnections between canals is quite large, the possibility of collateral circulation still exists. (auth)

8515 (ANL-6199(p.44-54)) AUTORADIOGRAPHIC DOSIMETRY OF MOUSE BONE CONTAINING Ca^{45}, Sr^{90}, or Ra^{226}. II. THE SENSITIVE REGION IN THE INDUCTION OF OSTEOGENIC SARCOMAS. John H. Marshall and Miriam P. Finkel.

Comparison of the Ca^{45} and Sr^{90} data suggests that dose to bone mineral and to osteocytes does not contribute significantly to the induction of osteogenic sarcomas. The sensitive region appears to be irradiated only by the particles that escape from microscopic bone surfaces. These include trabecular surfaces and the walls of haversian canals where present. The depth of this sensitive region has not been determined. Because most Ca^{45} and Ra^{226} hotspots are formed at bone surfaces that are growing at the time of injection, most of them are covered by continuing growth. Consequently, the time during which they can irradiate the sensitive region is limited. If the volume of bone (osteocytes and bone matrix) rather than the surface had been the region sensitive to the carcinogenic effect of radiation, the observed dose distribution together with the observed dose-response relation would have yielded an effective dose of roughly eight times, not twice, the diffuse surface dose. This discrepancy appears to be significant because the errors of the method probably do not exceed a factor of two. A speculation may be made that the burial of Ra^{226} hotspots reduces the effective nonuniformity of Ra^{226} distributions in man. The shape of the dose-response curves for Ca^{45} and Sr^{90} is discussed. (auth)

8516 (ANL-6199(p.55-61)) SOME CALCULATIONS OF THE NON-UNIFORMITY FACTOR IN THE INDUCTION OF BONE CANCER BY INTERNAL EMITTERS. John H. Marshall.

The nonuniformity factor in the induction of bone cancers by internally deposited radioisotopes is defined as the ratio of the effective dose level to the average dose level for a given distribution of radioactivity in bone. The term "effective dose level" means that level of a uniform dose distribution that would produce the same incidence of bone cancer as that produced by the given nonuniform dose distribution. The nonuniformity factor is a function of the shape of the dose-response curve for each local region of bone and a function of the maximum and minimum dose values and the shape of the dose distribution. Procedures are presented for calculations of the nonuniformity factor in the induction of bone cancer by internal emitters. (C.H.)

8517 (NYO-4629) STUDIES ON THE NATURE OF AND PROTECTION FROM RADIATION INJURY. ([New

York Univ., New York]). [nd]. 26p. Contract AT(30-1)-1290.

Preliminary data are presented from studies on the possible mechanisms involved in radiation injuries. Included are data from studies on the levels of adenilic acid, adenosine diphosphate, and adenosine triphosphate in livers from irradiated mice; the alkaline phosphatase activity in various tissues from irradiated mice; and tracer studies on the synthesis of adenosine triphosphate in vitro by liver mitochondria from irradiated mice. The effectiveness of various spleen extracts in protection against radiation injury was tested in three strains of mice of both sexes. Data pertaining to days survived and loss of weight of the experimental animals were analyzed statistically. Data are tabulated. Statistical analysis of the survival time for the irradiated mice shows that those which received an injection of spleen extract before irradiation survived a short, but statistically significant, time longer than those which received an injection after irradiation. (C.H.)

8518 (TID-11422) COMPARATIVE METABOLIC EFFECTS OF CERTAIN HORMONES AND X-IRRADIATION. Final Report [for] Period Covered January 1, 1958–December 31, 1960. O. H. Gaebler (Henry Ford Hospital. Edsel B. Ford Inst. for Medical Research, Detroit). 19p. Contract AT(11-1)-598.

Separate abstracts have been prepared on two sections of this report. (C.H.)

8519 (TID-11422(Sect.2)) CONTINUOUS METABOLIC STUDIES ON NORMAL AND DEPANCREATIZED DOGS DURING REPEATED WHOLE BODY X-IRRADIATION. O. H. Gaebler, R. J. Bloor, and Harold C. Choitz (Henry Ford Hospital. Edsel B. Ford Inst. for Medical Research, Detroit). Sect. 2 of COMPARATIVE METABOLIC EFFECTS OF CERTAIN HORMONES AND X-IRRADIATION. 19p.

Experiments on normal and depancreatized bitches were carried out to determine how well multiple doses of 90 r or less of x radiation are tolerated, and whether there are any metabolic effects suggesting stimulation or suppression of the adrenals. In two normal animals, total dosage for the main portion of the trunk was 574 and 3549 r, in 4 and 22 months, respectively; in the depancreatized one, 807 r in 9 months. Dosages for head and pelvis approximated 44% of these amounts. Food intake was constant, and daily records are kept of body weight, water intake, urine volume, and urine nitrogen. The general condition of all animals remained excellent. Periods of estrus continued. Weight was maintained or increased during long series of exposures. No changes in water balance or nitrogen output occurred which resembled those observed in dogs receiving corticotropin or hydrocortisone. In the depancreatized animal, the insulin requirement, known for 5 preceding years, was unaffected. Thus no evidence for stimulation or suppression of adrenal function was obtained. Histological examination of bone marrow and other tissues of the animal which received the largest total dose gave little evidence of damage. Moderate increases in urine volume of the normal animals suggested possible early renal impairment. (auth)

8520 (TID-11588) ENZYMATIC AND BIOCHEMICAL STUDIES OF EPIDERMIS WHICH HAS BEEN IRRADIATED WITH BETA PARTICLES. Progress Report for February 1, 1960 to January 1, 1961. (Albert Einstein Medical Center, Philadelphia). 20p. Contract AT(30-1)-1727.

Results are summarized from a study on the effects of 3000-rep β radiation from a $Sr^{90}-Y^{90}$ source on the activity of ribonuclease, desoxyribonuclease, acid phosphatase, alkaline phosphatase, and phosphodiesterase of albino guinea pig epidermis. Measurements were also made of 5 hydrolases after exposure to 600-rep β irradiation. Assay procedures for epidermal 5 nucleotidase, adenosinetriphosphatase, and pyrophosphatase were investigated. An attempt was made to detect nucleic acid breakdown products and changes in free amino acid patterns at 1, 3, and 6 days after exposure of skin to 3000-rep β irradiation. (C.H.)

8521 (TID-11729) FACTORS ELABORATED BY ANIMAL TISSUES WHICH STIMULATE RATE OF REGENERATION OF HEMATOPOIETIC ORGANS OF ANIMALS EXPOSED TO TOTAL BODY IRRADIATION WITH GAMMA RAYS. Technical Progress Report. Richard J. McAlpine (Parke, Davis and Co., Detroit). Jan. 18, 1961. Contract AT(11-1)-334. 76p.

A number of biological substances were evaluated for their protective effects against radiation injuries in rats. Materials screened include rat peritoneal exudate cells administered intravenously; various pituitary extracts; supernatant fluids from cultures of liver and adrenal cells; adrenal extracts; steroid compounds; 18 nucleic acid precursors; orotic acid; 4-amino-5-imidazole carboxamide-HCl; and glutamine. Data are tabulated. Extensive data are included on the protective effects of bone-marrow therapy against radiation injuries. Mechanisms whereby intravenous bone marrow is therapeutically beneficial in radiation injury are discussed. Data on bone-marrow therapy are correlated with nucleic acid precursor data. The effects of radiation dose, dose protective material, and route of administration of protective material on results are discussed. The pattern of mortality in treated and untreated rats following exposure to 1000 r whole-body irradiation is described. Data are summarized from a study of the degree of bone-marrow damage as reflected by the total nucleated cell count in the irradiated femurs from subtotally-shielded rats. The data are consistent with the concept that bone marrow is more radioresistant in vivo than is generally considered. Results are reported from a study which indicates there is no specific relations between the small intestine and bone marrow. Data are included from studies on the effect of rat bone marrow on hematopoietic recovery in sublethally irradiated monkeys and in autologously treated, lethally irradiated monkeys. (C.H.)

8522 (USNRDL-TR-479) INHIBITION OF BOWEL EPITHELIUM REGENERATION BY GRAFTED HOMOLOGOUS SPLEEN CELLS IN IRRADIATED MICE. P. C. Nowell and L. J. Cole (Naval Radiological Defense Lab., San Francisco). Nov. 16, 1960. 20p.

The study shows a direct immunological reaction of grafted genetically foreign spleen cells against the intestinal epithelium of irradiated mice. LAF_1 mice exposed to an x ray dose of 870 to 900 r and injected intraperitoneally with homologous (C_3H) or parental-strain (A or L) spleen cells died 4 to 8 days after irradiation, with pathological changes typical of the intestinal syndrome. The results indicate that the injected spleen cells produce accelerated deaths in the recipient irradiated mice by interfering in some way with normal regeneration of the irradiated bowel. The foci of viable myeloid and mononuclear cells observed in the adipose tissues of the abdominal cavity would seem to indicate a "take" of the graft. It is suggested that these accelerated deaths result from a specific homograft reaction of the implanted cells against the bowel epithelium of the host. (auth)

8523 (AEC-tr-4284) DATA ON THE REACTIONS OF THE HUMAN CENTRAL NERVOUS SYSTEM TO IONIZING

RADIATIONS. Yu. G. Grigor'ev. Translated from a publication of the State Publishing House of Medical Literature, Moscow, 1958. 133p.

Results are summarized from a survey of literature on the effects of ionizing radiation on the central nervous system. Results are included from experimental investigations and clinical observations. 285 references. (C.H.)

8524 (JPRS-4345) SELECTED TRANSLATIONS ON IRRADIATION IN MEDICINE AND CHEMISTRY. Translated from Voprosy Med. Khim., 6: 464-8; 475-7; 480-3; 497-504(1960). 39p.

Separate abstracts have been prepared for the 5 sections of this report. (C.H.)

8525 (JPRS-4345(p.1-7)) THE EFFECT OF EXTERNAL IONIZING RADIATION ON THE PARTICIPATION OF THE LIVER AND INTESTINE ON LIPID METABOLISM. K. V. Smirnov and V. A. Shaternikov. Translated from Voprosy Med. Khim., 6: 464-8(1960).

Following irradiation of dogs with γ rays of Co^{60} at a dose of 300 r, development of a hyperlipemia was observed in the early stages and terminal period of radiation sickness. The intestine of animals, in the early stages and terminal period of radiation sickness, supplied a significantly greater amount of lipids to the blood circulating through it, than before irradiation of the animals. In the early stages of radiation sickness the liver exhibited a compensatory effect on lipid changes in the blood, brought about by its passage through the intestine. However, in the terminal period, both the liver and intestine enriched effluent blood with lipids. (auth)

8526 (JPRS-4345(p.8-15)) OXIDATIVE AND CARBOHYDRATE-PHOSPHATE METABOLISM IN CEREBRAL AND HEPATIC TISSUE UNDER NORMAL CONDITIONS AND AFTER IRRADIATION. R. I. Skvortsova. Translated from Voprosy Med. Khim., 6: 475-9(1960).

During local cerebellar irradiation at a dose of 9000 r, the oxidative and carbohydrate–phosphorous metabolism is sharply inhibited two days after irradiation of the cerebellar tissue. In irradiated cerebellar tissue the formation of fructose–1,6-diphosphate is sharply inhibited. In addition to the fructose diphosphate, but to a significantly lesser degree, the formation of other phosphorous esters is also inhibited. These include phosphoglyceric acid, glyceryl phosphate, glucose-1-phosphate, glucose-6-phosphate, and fructose-6-phosphate. In the case of monobromacetic acid, carbohydrate–phosphorous metabolism is directed to the formation of fructose-diphosphate, in which case the inhibition of this compound's formation is sharply affected by radioactivity. An insignificant inhibition of carbohydrate–phosphorous metabolism was found in hepatic tissue during local cerebellar irradiation at a dose of 9000 r. The binding of mineral phosphate in the liver is rather sharply inhibited during irradiation of the intact head at a dose of 4000 r and also 2 to 5 days after total irradiation of the animal at a dose of 1000 r, as well as at the peak of radiation sickness. Both in the liver and in cerebellar tissue the formation of fructose-1,6-phosphate is primarily deranged. (auth)

8527 (JPRS-4345(p.30-7)) EFFECT OF CYSTAMINE ON THE LIVER AND SPLEEN CONTENT OF NUCLEIC ACIDS IN IRRADIATED RATS. V. G. Vladimirov. Translated from Voprosy Med. Khim., 6: 501-5(1960).

General irradiation with γ rays of Co^{60} at a dose of 600 r, causes a nucleic acid content reduction in the spleen of white rats, which is especially pronounced by the third day. Following irradiation, the amount of desoxynucleic acid in the liver decreased to a lesser degree than in the spleen, but normalization takes place significantly faster. A prophylactic administration of a 1% solution of cystamine, on the basis of 100 mg per 1 kg of animal weight, significantly prevents the reduction of the nucleic acid content in the spleen, and the desoxynucleic acid content in the liver, in the first days following irradiation. Its effect was not distinct at later periods. (auth)

8528 HISTOCHEMICAL EFFECTS OF X RADIATION. Antonio Pasqualino and Geoffrey H. Bourne (Univ. of Palermo, Italy and Emory Univ., Atlanta). Acta Anat., 42: No. 1-2, 1-11(1960). (In English)

Histochemical preparations of alkaline and acid phosphatase, esterase, and 5-nucleotidase have demonstrated that doses of x radiation varying from 150 to 800 r affect the activity of these enzymes in liver, spleen, and adrenal but not in kidney. Alkaline phosphatase and 5-nucleotidase were most affected by the radiation and acid phosphatase and esterase least affected. Succinic dehydrogenase activity was markedly reduced in the liver after irradiation by 600 r. (auth)

8529 SYSTEMIC INTERACTIONS IN RADIATION LEUKEMOGENESIS. Henry S. Kaplan (Stanford Univ. School of Medicine, Calif.). Acta Unio Intern, contra Cancrum, 17: 143-7(1960). (In English)

Evidences are reviewed with respect to interactions between systemic influences and a virus-like agent extractable from radiation-induced lymphoid tumors in mice, and active in the induction of similar tumors on neonatal injection into susceptible nonirradiated mice. Preliminary evidence suggests that the virus-like agent may require a large population of immature lymphoid cells for optimal proliferation, and that such populations of immature cells are made available under at least two experimental conditions, the normal external thymic cortex of the newborn mouse and the regenerating thymic cortex of the young irradiated adult mouse. Other evidence is presented which suggests that the inhibitory influence of bone marrow shielding or injection on thymic lymphoma development in irradiated mice is not mediated by way of immune mechanisms directed against the virus. (auth)

8530 HEALTH HAZARDS FROM IONIZING RADIATION. Charles L. Dunham. Arch. Environmental Health, 2: No. 2, 144-9(Feb. 1961).

The possible deleterious effects of small amounts of ionizing radiation in the environment, which have resulted from the testing of nuclear weapons, as a part of our national defense effort are discussed. Present concepts of the biological effects of radiation are reviewed. It is pointed out that sensitivity to ionizing radiations varies from species to species, from strain to strain, and among individuals of the same strain. For whole organisms such as man there is a very real ability to recover from even sizable doses of high dose rate total body exposures. No level of radiation exposure below which no effect will occur can be established. Present evidence indicates that relatively low levels of radiation in the environment will not increase the incidence of leukemia by more than 1 or 2 cases per 1,000,000 population per year, nor will the incidence of bone tumors and point mutations be increased appreciably. The average life span of a population would not be reduced by more than a few days at the most. (C.H.)

8531 PHYSIOLOGICAL EFFECTS OF EXTREMELY HIGH X-RAY INTENSITIES AND DOSAGES ON MICE. W. S. Moos, H. C. Mason, and M. Counelis (Univ. of Illinois,

Chicago and Illinois State Psychopathic Inst., Chicago). Am. J. Physiol., 199: 1101-4 (Dec. 1960).

The physiological effects of high-intensity x irradiation (2×10^5 r/min) and dosages of 1×10^6 r on mice (head and abdomen) were investigated. An increase in pulmonary and heart rates was observed. Electrocardiographic recordings after irradiation demonstrated reversal of wave components and increase of amplitudes. Blood counts present no changes except for a drop in leukocyte counts. Hemoglobin remained unchanged. A considerable increase in serum potassium and some indications of methemoglobin production were noted. Head-irradiated animals yielded a higher incidence of auricular congestion and brain hemorrhage in contrast to animals receiving abdominal irradiation. (auth)

8532 BIOCHEMICAL CHANGES AND INCREASED LIVER WEIGHT IN BONE MARROW CHIMERAS. A. L. Kretchmar and C. C. Congdon (Oak Ridge Inst. of Nuclear Studies, Tenn. and Oak Ridge National Lab., Tenn.). Am. J. Physiol., 200: 102-6 (Jan. 1961).

Female mice of two different strains were x-irradiated (950 or 900 r total-body) and then given 40×10^6 bone marrow cells from the same or a different strain of female donor mice. Irradiated mice lost weight during the first week after treatment. Mice given bone marrow cells showed good recovery except that when the cells were from a different strain there was a second weight loss persisting to the thirty-fifth day. The liver weight increased after treatment. The maximum was noted at 12 days. Glutamine and glutathione concentration in livers of treated mice was reduced at 12 days and the concentration of β-aminoisobutyric acid and of β-alanine was increased. The changes were greatest in animals given bone marrow cells of a different strain. (auth)

8533 ERYTHROPOIETIC RECOVERY AND RESIDUAL INJURY IN RATS EXPOSED REPEATEDLY TO X-RAYS. Seigmund J. Baum (U. S. Naval Radiological Defense Lab., San Francisco). Am. J. Physiol., 200: 155-8 (Jan. 1961).

Rats exposed repeatedly to 300-r x rays showed a decrease in Fe^{59} incorporation which attained its lowest point 48 hr postirradiation. Thereafter iron uptake increased until normal values were measured. This return to normalcy was delayed further with each newly repeated irradiation. On any day during the recovery period, Fe^{59} uptake decreased exponentially with repeated x irradiations. This decrease is a mesure of residual injury to the erythropoietic system. Since, after each repeated irradiation, a reduced amount of Fe^{59} was incorporated at the beginning of the recovery period, while the rate of recovery was similar, it is postulated that the decrease in radio iron uptake is due to an impairment in the functional capacity of the stem cells to proliferate erythrocytes. A working hypothesis for the calculation of erythrocyte stem cell damage is presented. Although the functional capacity of the stem cells to produce erythrocytes was reduced, the daily red cell turnover was normal. Only when this reduction was below a certain limit did a permanent anemia ensue. (auth)

8534 THE EFFECT OF IONIZING IRRADIATION ON THE LIPID COMPOSITION OF THE LIVER MITOCHONDRIA OF RATS. H. P. Schwarz, L. Dreisbach, M. Barrionuevo, A. Kleschick, and I. Kostyk (Philadelphia General Hospital). Arch. Biochem. Biophys., 92: 133-9(Jan. 1961).

The lipids of freeze-dried liver mitochondria of non-irradiated and x-ray irradiated rats were examined by chemical analysis, paper chromatography, infrared spectroscopy, and gas-liquid chromatography. A polyglycerolphosphatide fraction of great similarity with bis(phosphatidic) acid was isolated and tentatively characterized. Fatty acid analysis suggests that this fraction is not composed of a single lipid but of a group of lipids of different fatty-acid composition. Ionizing irradiation of the animals causes a significant increase of the mitochondrial polyglycerolphosphatides. As the other fractions were not similarly affected by the irradiation, polyglycerolphosphatide became one of the major lipid fractions of the liver mitochondria of irradiated rats. (auth)

8535 RADIOBIOLOGY OF MICRO-ORGANISMS. Th. Beck and R. Rőschenthaler (Landesanstalt für Landkultur und Moorwirtschaft, Munich). Bayer. landwirtsch. Jahrb., 37: No. 2, 1-82(1960). (In German)

A literature search is presented on the effects of radiation on microorganisms. The six topics covered are: physical basis for radiobiology, generalities on the importance of microorganisms in radiobiological research, radiation effects on cells and organisms, metabolic physiological changes caused by radiation, chemical radiation protection, and practical aspects of radiobiological research on microorganisms. (T.R.H.)

8536 IMPLANTATION OF RADIOACTIVE YTTRIUM IN THE PITUITARY FOSSA OF THE GUINEA PIG. Barbara E. Clayton, W. A. Langmead, and Janet M. Worden (Hospital for Sick Children, London and St. Thomas's Hospital Medical School, London). Brit. J. Radiol., 34: 120-8 (Feb. 1961).

The effect of implanting Y^{90} in the pituitary fossa of the guinea pig was studied. There was a suggestion of a fall in survival time up to a dose of 0.2 mc and clear evidence that 0.4 mc reduced the survival time. The histological changes observed in the pituitary and other endocrine organs are described. Changes in the pituitary resulted in endocrinological changes that included frequent abolition of the oestrus cycles, marked reduction in the uptake of I^{131} by the thyroid gland, and change in the pattern of excretion of urinary steroids. (auth)

8537 INCIDENCE OF LEUKAEMIA AFTER EXPOSURE TO DIAGNOSTIC RADIATION IN UTERO. W. M. Court Brown, R. Doll, and A. Bradford Hill (Western General Hospital, Edinburgh). Brit. Med. J., No. 5212, 1539-45(Nov. 26, 1960).

Evidence of the leukemogenic effect on the fetus of exposure to ionizing radiations in utero has been sought by comparing the leukemia mortality in a group of children whose mothers were known to have been irradiated during the relevant pregnancy with that expected from the corresponding sex-and-age specific national mortality rates. Pregnant women who received diagnostic irradiation directed toward their abdomen or pelvis between 1945 and 1956 were identified in the records of the radiological departments of eight hospitals in London and Edinburgh. Information about the date of birth and sex of the child was obtained from the corresponding maternity records. If the child left the hospital alive, his full name and the first names of his father were obtained from the local register or, in a few instances, from the Central Register of Births. The children who had died of leukemia were discovered by comparing the children's names with the list of names of all the children who had died of leukemia in Britain between 1945 and 1958. Altogether information was obtained about 39,166 liveborn children whose mothers were known to have been subjected to abdominal or pelvic irradiation during their pregnancy. Among their children, nine were discovered to have died of leukemia before the end of 1958. The expected number was estimated to be 10.5. There was

no evidence of any disproportionate occurrence of leukemia among the children who had been most heavily irradiated nor among the children who had been irradiated early in intrauterine life. Published data on the leukemogenic effect of irradiation in utero are conflicting. It is concluded that an increase of leukemia among children due to radiographic examination of their mother's abdomen during the relevant pregnancy is not established. (auth)

8538 LEUKAEMIA FOLLOWING RADIOIODINE TREATMENT OF THYROTOXICOSIS. E. Eric Pochin (University Coll., London). Brit. Med. J., No. 5212, 1545-50(Nov. 26, 1960).

Leukemia is known to have developed in 18 patients who had previously been treated with radioiodine for thyrotoxicosis, three cases having occurred in the United Kingdom, ten in the United States, four in Canada, and one in Austria. About 60,000 thyrotoxic patients have been treated with radioiodine in these four countries alone, with an estimated total of over 220,000 patient-years since treatment until mid-1960. Application of natural leukemia rates appropriate to the sex, age, and nation of these patients suggests that approximately 21 cases of leukemia would be expected to have occurred fortuitously among them whether radioiodine had been given or not. The numbers of patients treated in those countries in which cases of leukemia have not been observed would raise this total considerably. The intervals between radioiodine treatment and diagnosis of leukemia are consistent with a change distribution. Of the 17 cases in which the type of leukemia is known, 13 were diagnosed as acute, a proportion somewhat, but not strikingly, higher than that to be expected on the basis of data for England and Wales on the frequency of acute leukemia in a normal population of corresponding age and sex. These estimates are held to indicate that the present known records of cases in which leukemia has followed radioiodine treatment of thyrotoxicosis gives no indication that this treatment is inducing leukemia. At the same time they clearly do not exclude this possibility, since the total number of cases of leukemia might greatly exceed the number at present known to have occurred. (auth)

8539 LEUKAEMIA IN CHILDHOOD AFTER ANTENATAL EXPOSURE TO X RAYS. A SURVEY OF QUEEN CHARLOTTE'S HOSPITAL. T. L. T. Lewis (Guy's Hospital, London). Brit. Med. J., No. 5212, 1551-2(Nov. 26, 1960).

Although the figures obtained so far are not large enough to show a tendency for irradiation of the fetus to cause one case of leukemia in 40,000 births they do show that the tendency is not very much greater. The incidence of 8 leukemic deaths per 16,948 live births, 1 in 2,118, is slightly higher for Queen Charlotte's Hospital than for the country as a whole; but this is due to the much higher incidence of leukemic deaths in the nonirradiated (control) group, 1 in 1,808, compared with the irradiated group, 1 in 4,291, and cannot therefore have been caused by irradiation. (auth)

8540 EVIDENCE OF RADIOSENSITIVE STAGES DURING THE EMBRYONIC DEVELOPMENT OF GRYLLUS BIMACULATUS. Colette Séréno (College de France, Paris). Compt. rend., 251: 2430-2(Nov. 21, 1960). (In French)

The radiosensitivity of the cricket embryo at various stages of development was studied. Embryos were exposed at ages 2, 24, 48, and 72 hr and 4, 5, 6, 7, 8, and 9 days to 250 to 350 r. The variations in the percentage of hatching and the variation in the length of embryogenesis were used as the criteria to evaluate the radiation effects. The two radiation doses had essentially the same effect. The results showed that the radioresistant stages are characterized by zero (2 hr) or slow (48 hr) mitotic activity. In the radiosensitive stages corresponding to periods of intense mitotic activity, the radiation doses used appeared to either completely stop the embryonic development or to have no effect at all. (J.S.R.)

8541 TEST OF DESTRUCTION BY LOCALIZED IRRADIATION WITH X RAYS OF THE HYPOPHYSIAL ROOTS OF THE EMBRYO OF THE BLINDWORM (ANGUIS FRAGILIS L.). Albert Raynaud (Inst. Pasteur, Seine-et-Oise, France). Compt. rend., 251: 2416-18(Nov. 21, 1960). (In French)

The attempted hypophysectomy of embryos of the blindworm with localized x radiation was studied, and the first results of this study are presented. The embryos were irradiated on the head with 16,000 to 18,000 r. The application of this dose caused arrest of the development in the region of the irradiated head and a radionecrosis in all parts of the brain crossed by the x-ray beam. Outside the radiation zone, the embryos had normal proportions. The most surprising phenomenon observed was the persistence in the irradiated male embryos of the Müller canals. In all the irradiated embryos the thyroid showed hypodevelopment. (J.S.R.)

8542 CHANGES IN THE PERIPHERAL BLOOD AND BONE MARROW OF RATS AT VARIOUS PERIODS AFTER ADMINISTRATION OF A SINGLE X-RAY DOSE. N. I. Shmeleva. Doklady Akad. Nauk, S.S.S.R., 133: 1455-7 (Aug. 21, 1960). (In Russian)

The leucocyte count and blood formula were determined at 3, 9, 16, 21, 30, 90, 180, 270, and 360 days after the irradiation of rats with a dose of 500 r. At 30 days the per cent and absolute number of segmented neutrophils was twice the initial level, and the per cent of lymphocytes was 68.3%, compared to 81.7% before irradiation. At 90 days the per cent of polymorphonuclear neutrophils was 1.9%, compared to 0.9% before irradiation, while the per cent of segmented neutrophils increased from 14 to 22.4%. At 180 days a shift to the left was observed in the blood formula. The per cent of polymorphonuclear neutrophils rose to 5.4%. The number of mature neutrophils was twice the initial level. The per cent and absolute number of lymphocytes was significantly lower than in unirradiated rats. At 270 days the number of leucocytes in the irradiated rats exceeded that of the controls by a factor of 1.5. The shift to the left was more pronounced with the number of polymorphonuclear neutrophils exceeding that of the controls by a factor of 5. At this time hyperplasia of the bone marrow occurred (36.3 mg vs. 16 mg for the weight of bone marrow in the control rats). At 360 days a further increase in the weight of the bone marrow and the number of nucleated cells was observed. (TTT)

8543 THE ACTION OF X-RAY RADIATION ON THE CONTENT OF NUCLEIC ACIDS IN CELL NUCLEI OF BONE MARROW. V. Ya. Brodskiĭ and I. A. Suetina. Doklady Akad. Nauk, S.S.S.R., 134: 439-42(Sept. 11, 1960). (In Russian)

The content of nucleic acids (RNA and DNA) in separate young cells (myeloblasts) and mature cells (neutrophils) was determined in the unharmed cells of bone marrow taken from mice given a dose of 700 r. Treatment with cold (+1°C) 5% $HClO_4$ with contact times of 7, 15, and 40 min and 1, 2, 3, 4, 6, 24, and 48 hr, and with hot (90°C) 5% $HClO_4$ for 6 and 15 min was used to separate various fractions of nucleic acid from the young cells (myeloblasts) and mature

cells (neutrophils). Six hours after irradiation it was found that the fraction of RNA remained the same, but that the concentration of DNA decreased in both the myeloblasts and the neutrophils. Even if the organ from which the bone marrow was taken was shielded from the direct irradiation, the content of DNA was still found to be low. These results point to the injury of certain general systems of the organism. A four-fold decrease in the amount of DNA in myeloblasts subject to direct irradiation may be the cause for the slow-down in mitotic activity and death of these cells. The relative stability of neutrophils to the action of radiation may be due to the smaller content of DNA in these cells and also to the fact that the neutrophils do not divide. (TTT)

8544 EFFECT OF γ IRRADIATION ON BLOOD LIPIDS. I. N. Bhatt, T. A. Venkitasubramaniam, and R. Viswanathan (Univ., Delhi, India). Experientia, 16: 537 (1960). (In English)

The effect of whole-body irradiation with Co^{60} γ radiation on the blood lipids of rats was investigated. The total blood lipids were increased by about 38.8% 24 hr after the irradiation. The cholesterol and phospholipid concentrations of the blood remained unchanged. (tr-auth)

8545 EFFECTS OF X-IRRADIATION ON MUSCLE MEMBRANE. A. Portela, M. Hines, J. C. Perez, D. Brandes, G. H. Bourne, P. Stewart, and D. Groth (Emory Univ., Atlanta). Exptl. Cell Research, 21: 468-81(Dec. 1960).

X irradiation of frog muscle from 50 to 10,000 r did not produce early changes in the content of sodium or potassium, the permeability of the muscle membrane, ion fluxes, resting and action potentials, membrane resistance, or membrane capacitance. This dose range of irradiation did not alter the relation between resting membrane potential and temperature, nor that between resting membrane potential and external potassium-ion concentration. Furthermore, the mechanical responses of frog muscle, such as contraction time, relaxation half time, twitch tension, maximal tetanus tension, and optimal stimulus frequency were also unchanged by irradiation at 50 to 10,000 r. The temperature dependence of each of these parameters was studied in detail. On the other hand, preliminary studies now in progress suggested that higher doses (50,000 and 100,000 r) significantly increased the permeability of the muscle membrane to potassium ions. (auth)

8546 NUCLEAR UPTAKE OF DNA FRAGMENTS AFTER INJECTION OF ^{32}P-LABELLED THYMOCYTES IN LETHALLY IRRADIATED MICE. M. Hill and V. Drášil (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Exptl. Cell Research, 21: 569-82(Dec. 1960).

Twenty-four hours after total-body irradiation with 800 r mice were injected with a suspension of homologous living P^{32} thymocytes, with a suspension of P^{32} thymocytes killed by ultraviolet irradiation, and with a corresponding amount of P^{32} in the form of $Na_2H\ ^{32}PO_4$. There was greater retention of radioactivity at 24 and 48 hr after the injection of cells than after the injection of inorganic P^{32} in the spleen and liver. Labeled cells morphologically identical with thymocytes were found only in the thymus, bone marrow, and spleen. After the injection of living or dead cells, as well as after the injection of inorganic P^{32}, diffuse radioactivity was found in the thymus, spleen, and bone-marow autoradiographs. The sinusoids and cytoplasm, as well as the nuclei of liver cells, were active in the liver; the vessel lumina, glomerular capillaries, both layers of Bowman's capsule and proximal, less frequently also the distal tubules in the kidney; the epithelium surface, intercellular spaces and blood vessels of the mucous membrane, and, diffusely, the crypt epithelium were active in the duodenum. After the removal of all non-DNA phosphorus and after injection of living or dead thymocytes, labeled lymphocyte-type cells were found, as well as Feulgen positive fragments in the thymus, spleen, and bone marrow. Up to 3 hr after injection, the label was observed in the nuclei of reticular cells of the thymus, spleen, and bone marrow; in the nuclei of the endosteal cells of the femur; in the neutrophils; and in the cytoplasm of the reticular and endosteal cells. After the injection of inorganic P^{32}, activity of DNA-P^{32} was found only in two mice of the 3-hr stage; it was confined to the same types of cells as those found after the injection of cell suspensions. It is suggested that the activity of nuclei of resting cells of the thymus, spleen, and bone marrow is caused by the uptake of large DNA fragments of injected and disintegrated P^{32} thymocytes. In the case of injection of inorganic P^{32}, the findings are interpreted by the uptake of DNA-P^{32} originating from the thymocytes that disintegrated after being labeled during premitotic DNA synthesis. (auth)

8547 THE DESTRUCTION OF SALMONELLA BACTERIA IN REFRIGERATED LIQUID WHOLE EGG WITH GAMMA RADIATION. D. A. A. Mossel (Central Inst. for Nutrition and Food Research T.N.O., Utrecht). Intern. J. Appl. Radiation and Isotopes, 9: 109-12(Dec. 1960). (In English)

It was attempted to use ionizing radiation for rendering whole egg, intended for preservation by other methods than freezing, free from Salmonella. Initial densities of about 10^7/ml of S. typhimurium and S. senftenberg were used. Irradiation was carried out with a ~1500-c Co^{60} source, the inoculated whole egg being packed in lacquered tins and kept at ~1°C during this treatment. Six decimal reductions of the Salmonella species tested were obtained at dosages of 2×10^5 rad and nine reductions at slightly over 5×10^5 rad. No effect of the use of specific recovery media or pretreatments on the apparent dose value required for obtaining these reductions could be established. The odor of the whole egg and its functional properties appeared to have been impaired at dosages of 10^4 rad, while the color suffered from $\sim 2 \times 10^5$ rad. Therefore the radiation pasteurization of liquid whole egg at ~1°C cannot be considered a promising process. (auth)

8548 THE DEVELOPMENT OF MOUSE OVARIES AFTER LOW-DOSE IRRADIATION AT BIRTH. Hannah Peters and Kirstine Borum (Finsen Inst. and Radiumstation, Copenhagen). Intern. J. Radiation Biol., 3: 1-16 (Jan. 1961). (In English)

A single dose of 20 r of x rays given to mice at birth influences the development of their ovaries considerably. The effect becomes evident a few hours after radiation, and the damage can be traced in the infantile and prepubertal ovaries and in the organs of young mature animals. The immediate damage seems to be due to the marked radiation sensitivity of oocytes in pachytene, i.e., the prestationary stage of meiotic prophase, in which many of the oocytes still are in the mouse on the day of birth. Oocytes in pachytene disappear quickly after radiation, whereas oocytes already in the stationary phase of meiosis at the time of radiation seem more resistant to immediate damage. Although irradiated animals start to ovulate at about the same age as normal animals and produce morphologically normal ova soon after they reach maturity, histological analysis reveals marked degeneration and destruction of parts of the ovary at that time. (auth)

8549 CREATINE METABOLISM AFTER X-IRRADIATION OF RATS. Georg Gerber, Gisela Gerber, K. I. Altman, and L. H. Hempelmann (Univ. of Rochester School of Medicine and Dentistry, N. Y.). Intern. J. Radiation Biol., 3: 17-22(Jan. 1961). (In English)

Creatine-2-C^{14} was injected into rats at different times after x- or sham-irradiation. Muscle creatine and phosphocreatine, as well as creatine from blood, kidney, and urine, were isolated and their respective specific activities determined. Urinary creatinine was also isolated and its C^{14}-activity determined. Coincident with the maximal excretion of creatine, the specific activities of muscle creatine and phosphocreatine decreased after x irradiation. Immediately after injecting the x irradiated rats with creatine-2-C^{14}, the specific activity of urinary creatine increased, whereas that of creatinine decreased, but at a somewhat later time. It is postulated that defective utilization of creatine by muscle constitutes the cause of radiation-induced creatinuria. (auth)

8550 EFFECT OF IRRADIATION OF THE PRIMER DNA ON THE INCORPORATION OF PRECURSORS. C. M. Wheeler and S. Okada (Univ. of Rochester School of Medicine and Dentistry, N. Y.). Intern. J. Radiation Biol., 3: 23-7(Jan. 1961). (In English)

The rate of enzymatic incorporation of H^3-labeled thymidine into primer DNA was studied after the DNA had been irradiated with doses up to 360,000 roentgens of γ rays. Nonirradiated DNA-synthesizing enzyme obtained from regenerating rat liver was used together with DNA in the incubation system. An initial increase followed by a decrease was noted in one sample of DNA, whereas a second less-highly polymerized sample showed only a decrease in the rate of incorporation. Isolated calf-thymus nuclei showed no changes in the rate of incorporation of H^3-labeled thymidine or cytidylic acid after irradiation with very high doses of γ rays. The results of these in vitro studies do not provide support for the concept that damage to DNA preventing replication is a factor in the decrease in DNA-synthesis noted in irradiated cells. (auth)

8551 RADIOSENSITIVITY OF OOGONIA AND OOCYTES IN THE FOETAL RAT. Heather M. Beaumont (Univ. of Birmingham, Eng.). Intern. J. Radiation Biol., 3: 59-72(Jan. 1961).

Pregnant rats were exposed to doses of 25 to 2 × 100 r of x rays at varying times between the 13th and the 20th days after insemination. Female offspring were killed at 25 days post partum, and the number of oocytes was estimated from serial sections of the ovaries. The population of oocytes in the irradiated ovaries was found to depend both on the dose of x rays administered and on the fetal age at the time of exposure. The period of maximum radiosensitivity, which occurred on the 15th day of gestation, was found to coincide with a high rate of mitotic division of oogonia. (auth)

8552 CHROMOSOME DAMAGE AND GROWTH REDUCTION PRODUCED IN ROOTS OF VICIA FABA BY X-RAYS AND BY TRIETHYLENE MELAMINE. John Read (Wakari Public Hospital, Dunedin, New Zealand). Intern. J. Radiation Biol., 3: 95-8(Jan. 1961).

If groups of broad-bean roots are treated with x rays or by immersion in triethylene melamine solution and if the doses are adjusted so that the subsequent reduction in growth is equal, the cells of the root-tips carry equal numbers of chromosome aberrations. This had previously been shown when x rays and 8-ethoxycaffeine were compared. (auth)

8553 BACKGROUND RADIATION AS THE CAUSE OF FATAL CONGENITAL MALFORMATION. A FURTHER COMMENT ON THIS SUBJECT. Austin M. Brues (Argonne National Lab., Ill.). Intern. J. Radiation Biol., 3: 99-100 (Jan. 1961).

The wide discrepancy in reported rates of fatal congenital malformation is attributed to the frequency and accuracy of vital reporting methods. Criteria for reporting still-births vary from one country to another. This would affect any data on background radiation as the cause of fatal congenital malformation. (C.H.)

8554 TAURINE EXCRETION IN HUMANS TREATED BY TOTAL-BODY RADIATION. Ralph R. Cavalieri, Milton Van Metre, F. W. Chambers, Jr., and E. Richard King (National Naval Medical Center, Bethesda, Md.). J. Nuclear Med., 1: 186-90(July 1960).

Urinary taurine was found to increase following total-body radiation in three patients given single doses of 450 r or greater. A cumulative increase in taurine excretion appeared in three other patients who received multiple 100 r doses. (auth)

8555 DOSE-RESPONSE RELATIONSHIP IN RADIATION CARCINOGENESIS. Niels Arley and Reidar Eker (Norsk Hydro's Inst. for Cancer Research, Norway). Nature, 189: 151-2(Jan. 14, 1961).

Data on dose-response relationship and threshold dose in radioinduced neoplasms are discussed. The author presents an analysis of statistical data which he interprets as indicating that the direct one-hit form of the somatic mutation hypothesis actually leads to a sufficiently flexible dose-response curve which can be fitted with qualitative agreement to experimental values showing not only a linear form but also a sigmoid form and a form with a maximum. In some cases a threshold is simulated. Thus it is shown that radiation carcinogenesis does not show one and the same form of dose-response curve common to all cases, but the form varies from case to case, depending on the experimental conditions and the relative importance of the effects of toxicity, elimination, and adaptation in each specific case. (C.H.)

8556 MODIFICATION OF RADIATION DAMAGE IN SEEDS BY POST TREATMENT. W. Klingmüller (Univ. of Giessen, Ger.). Nature, 189: 413-14(Feb. 4, 1961).

An investigation was made of the effects of moisture on the radiosensitivity of seed of Vicia faba. Seeds of different water content were exposed to doses of 3,000 or 10,000 r x radiation, and measurements were made of root and shoot growth in seedlings grown from the exposed seeds. Data are tabulated. Results show an effect from both dosages of radiation but no clear effects of moisture content. (C.H.)

8557 EXPERIMENTAL STUDIES ON THE EFFECT OF SEVERAL DRUGS UPON THE SUBCUTANEOUS TISSUE REACTION FOLLOWING X-RAY IRRADIATION. Masako Sakai (Osaka City Univ. Medical School, Osaka). Osaka Shiritsu Daigaku Igaku Zasshi, 9: 2529-45(Aug. 1960). (In Japanese)

The effects of irradiation on subcutaneous connective tissue of rabbits were studied after supravital staining. Irradiation induced the immigration of granulocytes from blood vessels into the tissue during the first 8 to 12 hr postexposure. These degenerate and are engulfed by monocytes during the second or third day. The monocytes increase in number during the first to third day after irradiation. Local applications of adrenaline, noradrenaline, phenylephline, naphazoline, or atropine inhibited the tissue reaction. (C.H.)

8558 CARCINOSARCOMA OF THE MAMMARY GLAND ARISING IN A MONKEY AFTER HYPEROESTRINI-

ZATION AND ADMINISTRATION OF RADIOACTIVE SILVER (^{110}Ag). E. Ia. Smoilovskaia, A. V. Vadova, M. Ia. Podval'naia, and I. A. Chachibaia (Inst. of Experimental Pathology and Therapy, Academy of Medical Sciences, USSR). Problems of Oncol. (U.S.S.R.) (English Translation), 6: 666-75 (1960).

Preliminary results are presented from a study on 7 monkeys exposed to prolonged hyperoestrogenation without any additional intervention for a period of 4 to 6 years. No signs of malignant growth were observed in the mammary glands. A second group of 6 monkeys was observed for 3 years after hyperoestrogenation, which was followed by the implantation of Ag^{110} in the mammary region. The radiation dose to surrounding tissues was about 80 rad/day on the first day after implantation of Ag^{110} mammary carcinomas developed in two of the animals in this group. Clinical and histological findings on biopsy material are presented for one case in which mammary tumor formation was observed about 6.5 years after the beginning of hyperoestrogenation and 3.5 years after the administration of Ag^{110}. It is postulated that the development of the tumor represents a protracted process consisting of a sequence of consecutive changes, with the radiation dose regarded as the most important factor in tumor formation, and that the dyshormonal state caused by the continuous hyperoestrogenation of the monkey played the role of a promoting, or cocarcinogenetic, factor. Tumors were also produced in the mammary tissues in monkeys by radioactive preparations alone, applied for the same length of time as in the case reported, but without additional hyperoestrogenation. Based on the observations, it is concluded that the dyshormonal state plays the most important role in the process of carcinogenesis in the mammary glands of monkeys. (C.H.)

8559 ACCELERATED DNA SYNTHESIS IN ONION ROOT MERISTEM DURING X-IRRADIATION. Nirmal K. Das and Max Alfert (Univ. of California, Berkeley). Proc. Natl. Acad. Sci. U. S., 47: 1-6(Jan. 1961).

The effects of various doses of x rays on DNA synthesis and on the nucleohistone complex in individual onion root tip cells have been studied using both microspectrophotometric and autoradiographic methods. Cell proliferation is inhibited by x rays. The process of DNA synthesis, on the contrary, is stimulated during irradiation and continues to the premitotic level in a period of complete mitotic inhibition. The normal cytochemical properties of the nucleohistone complex appear unchanged, even after heavy irradiation. (auth)

8560 EVIDENCE OF PRENATAL HETEROSIS RELATING TO X-RAY INDUCED CONGENITAL ANOMALIES. R. Rugh, E. Grupp, and M. Wohlfromm (Columbia Univ., New York). Proc. Soc. Exptl. Biol. Med., 106: 219-21(Jan. 1961).

Embryonic mice at 8.5 days gestation from pure C57 and CF1 strains and their hybrids were x irradiated to 200 r to determine whether or not prenatal heterosis was manifest. Criteria were the number of normal, resorbed, dead, or anomalous mice seen at 18.5 days in the hybrids as compared with the pure lines. The hybrids at 8.5 days exhibited some degree of heterosis based upon the higher percentage of normal fetuses and the lower percentage of resorptions when comparisons were made with the pure strain parental stocks. For heterosis to be manifest, the hybrids had to overcome the severely deleterious effect of the presence of C57 genes as indicated by the 90% resorptions among this parental stock and only 30% in the hybrids, whereas the CF1 showed 39%. Thus there is evidence of more than mere dominance of the more resistant strain genes which leads to heterosis at least by the time of organogenesis. The heterosis for the embryo results in better survival and thus better survival also of the x-irradiation-produced congenital anomalies. (auth)

8561 EXPERIMENTS ON EFFECTS FROM RADIATION IN RABBITS WITH RESPECT TO THE PROBLEM OF HOMOPLASTIC GRAFTING. Alessandro Migliaccio and Antonino Garaffo (Univ., Catania, Italy). Radiobiol. latina, 3: 21-30(Jan.–March 1960). (In Italian)

Skin was homografted on rabbits whole-body irradiated with a lethal dose of x radiation and protected by bone marrow transplantation. It was concluded that in animals subjected to radiation, and protected with bone marrow, development of homoplastic tissue from the same individual which furnished the bone marrow can occur. (auth)

8562 THE ALKALINE PHOSPHOMONOESTERASE ACTIVITY OF THE NEPHRON OF THE RAT EXPOSED TO X RADIATION LOCALIZED IN THE RENAL OR PELVIC REGION. I. de Simone, U. Nuvolone, G. Pisani, and M. L. Tognacca (Univ., Messina, Italy). Radiobiol. latina, 3: 31-51(Jan.–March 1960). (In Italian)

Using Gomori's method, with various incubation times, the changes in the alkaline phosphatase in the rat's kidney after irradiation with 2000 r, either localized to the left kidney, to both kidneys, or to the whole pelvis, were studied. The animals were sacrificed 6 and 24 hr and 5, 30, and 60 days after irradiation. Irradiation of the left renal field caused a considerable reduction in phosphatase activity in the left kidney and a corresponding but lesser diminution in the right kidney. Irradiation of both renal fields or of the pelvis caused an equal diminution in both kidneys, but more marked in the former case. (auth)

8563 VARIATIONS OF THE BETA-GLYCURONIDASIC ACTIVITY IN ORGANS OF THE WHOLE-BODY IRRADIATED GUINEA PIG. A. Billitteri and A. Gasso (Univ., Catania, Italy). Radiobiol. latina, 3: 63-71(Jan.–March 1960). (In Italian)

A study was made of the behavior of the β-glycuronidasic activity (according to Huggins, Talalay, and Tischmann's method) after 2 and 5 hr and 1, 3, and 8 days following panroentgenirradiation on homogenized brain, liver, spleen, adrenals, kidney, testicle, ovary, and plasma of 65 full-grown guinea pigs. The study of the data obtained shows that panroentgenirradiation (at a dosage of 250 to 500 r) considerably modifies the enzymatic activity both of the blood and the organs. Both in the blood and in the organs it could be established that there exists an increase of the β-glycuronidasic activity directly proportional to the intensity of the damage due to ionizing radiations, which is followed by a decrease 8 days after irradiation. The phenomenon is discussed, and different theories are advanced for its interpretation. (auth)

8564 THE EFFECT OF HIBERNATION ON THE VARIATION OF THE BETA-GLYCURONIDASIC ACTIVITY OF THE BLOOD AND THE TISSUES FOLLOWING IRRADIATION. G. Gasso and A. Billitteri (Univ., Catania, Italy). Radiobiol. lattina, 3: 73-81(Jan.–March 1960). (In Italian)

In blood of 15 guinea pigs and on homogenized liver, spleen, adrenals, kidney, testicle, and ovary of 30 guinea pigs, the variations of β-glycuronidasic activity due to whole-body x irradiation which was made during or after a period of hibernation were studied. It was concluded that artificial hibernation modifies the enzymatic activity of irradiated animals from a qualitative and quantitative point of view. The characteristics of these phenomena are then discussed. (auth)

8565 ALTERATION OF MUTATION FREQUENCY BY TREATMENT WITH ACTINOMYCIN D. Walter J. Burdette (Univ. of Utah Coll. of Medicine, Salt Lake City). Science, 133: 40(Jan. 6, 1961).

The frequency of lethal mutations occurring in Drosophila melanogaster was reduced by approximately one-half when irradiated males were treated with actinomycin D, which also inhibited the appearance of melanotic atypical growths in the strain used for the study. (auth)

8566 INVESTIGATION ON THE EFFECT OF VARIOUS RADIATION QUALITIES AND RADIATION DOSES ON THE SERUM ALBUMIN AND BLOOD PICTURE OF RATS. Karl Peters and Robert Bauer (Universität, Tübingen, Ger.). Strahlentherapie, 113: 553-83(Dec. 1960). (In German)

The examination of the action of various doses and qualities of radiation showed in part, from the survival rates and relative organ weights, significant differences between dose and dose, and similarly between radiation quality and radiation quality. The dynamics of the changes in the serum albumen during the elapse of 38 days p.r. showed for the animals dying during the time of experimentation broadly the already described picture of decrease in albumin and globulin, which arises after irradiation. On the other hand the changes in the serum albumen of the surviving animals was not measured with this scheme. Two cases of hyperalbuminemia, one of which was correlated with hypergammaglobulinemia, were emphasized. The initial increase in the albumin values on the 1st and 4th day p.r. were interpreted as mobilized deposited albumin. A corresponding, but less intense increase in the α-globulin on the 1st day p.r. could also be interpreted as released deposits, or as compensatory resistance reactions of the organism, following the adaptation syndrome after Selye. The total picture of the measured changes in the serum protein after radiation allows a dysproteinemia to be recognized which is far more complex than was already supposed. By means of single examples and group values the importance of the final situation for the survival of the radiation insult was pointed out. Decreased albumins, raised β and α globulins as well as increased leucocyte count at the time of radiation offers a favorable survival prognosis. The relation between the protein values of serum and the corpuscular hemogram values was discussed. It can be deduced from the sum of the present findings that after whole-body radiation of rats the dysproteinemia and the disregulation of the regenerative courses of reaction after radiation with electrons in the examined dose area, are unambiguously slighter than after the radiation with ultrahard x rays or x radiation from 200 kv. (auth)

8567 BEHAVIOR OF ELECTROLYTES AND ENERGY PRODUCING PROCESSES IN THE SPLEEN AFTER INTRAOPERATIVE LOCALIZED X RADIATION. Heinz Breuer and Heinz Karl Parchwitz (Chirurgische Universitätsklinik und- Poliklinik, Bonn). Strahlentherapie, 113: 595-602 (Dec. 1960). (In German)

The influence of an x-ray radiation was examined on the concentration of potassium and sodium as well as of the behavior of the endogenous respiration and the anerobic glycolysis of the spleen tissue. The in vivo intraoperative single phase locally delivered dose was 6000 r. Directly after the radiation the anerobic glycolysis was inhibited. A decrease in the oxygen uptake appeared first 12 hr after radiation. Earlier than the inhibition of the endogenous respiration a loss in potassium of the spleen cells could be observed. Forty-eight and 192 hr after radiation it was possible to prove an increase of potassium in comparison with the control values. Through a confrontation of the biochemical findings with the histologically provable changes an attempt was made to obtain an insight into the dynamics of the radiation reaction. (auth)

8568 INVESTIGATIONS ON A BIOLOGICAL RADIATION PROTECTION. XXXVII. THE CONTRIBUTION OF THE ADENYLACID SYSTEM AND OF PYRIDOXAL-5-PHOSPHATE ON THE RADIATION PROTECTION EFFECT OF SEROTONIN. Hanns Langendorff, Hans-Joachim Melching, and Helmuth Rösler (Universität, Freiburg i. B.). Strahlentherapie, 113: 603-9(Dec. 1960). (In German)

A report is given on the share of the adenylacid system and of the pyridoxal-5-phosphate on the radiation protection effect of serotonin. It is evident there is a clear resistance increase in white mice with the intake of pyridoxal-5-phosphate, adenosintriphosphate and also adenosinmonophosphate. Through the combined dose of pyridoxal-5-phosphate + adenosintriphosphate or adenosinmonophosphate, an additivity in the protection effect is obtained, which approaches closely the effect of serotonin. If one gives animals serotonin plus adenosintriphosphate or adenosinmonophosphate, the protection effect is stronger than by the dosage of serotonin alone. The importance of adenosinmonophosphate, adenosintriphosphate, pyridoxal-5-phosphate, and serotonin in connection with radiation processes is discussed. (auth)

8569 RADIATION REACTION IN EXPOSURE TO EXTREMELY HIGH DOSES. Wilhelm Börner, Kurt Elster, Helmut Riemann, and Felix Wachsmann (Universität, Erlangen, Ger.). Strahlentherapie, 114: 48-54(Jan. 1961). (In German)

A report is made on radiations of rat tails with 20 million r of a soft x radiation (50 kv, 0.06 mm Al HVL). The high dosage produces after 12 to 24 hr an acute necrotical decay of the bradytrophic tissue of the bone. Histologically there are no cellular reactions or gradual stages of the radiation reaction. The latent time is shortened to a few hours by using extremely high doses. (auth)

8570 EXPERIMENTAL IRRADIATION NEPHRITIS IN RABBITS. Franz Moser, Hans Sarre, Clara Hein, and Hans-Joachim Melching (Universität, Freiburg i. B.). Strahlentherapie, 114: 76-93(Jan. 1961). (In German)

A radiation nephritis was produced in rabbits through two different radiation methods (percutaneous irradiation and after operative exposure). Isolated irradiation of rabbits' kidneys resulted in damage with retention of the excretory substances of the urine in the blood. A chronic disease developed with a persistent residual nitrogen increase (phase of the compensated retention), until finally, after some months, death from uremia followed. (auth)

8571 THE EFFECT OF CYSTEINE ON THE RADIO-INDUCED MUTATION RATE IN ESCHERICHIA COLI. Hans A. Künkel, Paul Kamm, and Günter Höhne (Universitäts-Frauenklinik, Hamburg-Eppendorf, Ger.). Strahlentherapie, 114: 94-102(Jan. 1961). (In German)

A leucin dependent shortage-mutant II-20 and a streptomycin dependent mutant X-41 were isolated from a relatively radiation resistant species E. coli B/r. The protective action of cysteine (0.01-m) on the original species as well as on the leucin dependent mutants was examined at doses up to 80,000 r with reference to the inactivation of the bacteria. Cysteine caused in the whole dose range a significant decrease of the inactivation rate. Thereafter the reverse mutation rate to the wild type after radiation was examined with the same dose range on both mentioned biochemical mutants. Application of cysteine before radia-

tion reduced the number of the reverse mutations considerably. Application of cysteine without radiation brings about no change of the spontaneous mutation rate. (auth)

8572 INVESTIGATIONS ON A BIOLOGICAL RADIATION PROTECTION. XXXVIII. THE EFFECT OF CYSTEAMINE AND SEROTONINE ON THE RETICULOCYTES AND IRON METABOLISM OF IRRADIATED ANIMALS. Dieter Eitgen, Ruprecht Koch, and Hanns Langendorff (Universität, Freiburg, I. B.). Strahlentherapie, 114: 118-27(Jan. 1961). (In German)

The disordering of the Fe^{59} structure in young erythrocyte populations by 75-r whole-body irradiation is not influenced by treatment of the rats with cysteamine or serotonin. The Fe reabsorption from the serum in mice with whole-body doses of 1600 or 3200 is not affected by serotonin as a radioprotective material. (tr-auth)

8573 BASIC DATA FOR EXPERIMENTS ON EMBRYONIC DAMAGE BY IONIZING RADIATION. Johannes Trautmann (Stadt. Krankenhaus Moabit, Berlin). Strahlentherapie, 114: 147-52(Jan. 1961). (In German)

Some important basic research for experiments on radiation conditioned embryo damages are pointed out. Without this research, not considered in some recent works, one cannot judge sufficiently the embryo damage caused by ionizing rays. (auth)

8574 IMMUNE STATUS OF IRRADIATED MICE TREATED WITH ADULT BONE MARROW AND FETAL HEMATOPOIETIC TISSUE. N. Gengozian, I. S. Urso, R. R. Carter, and T. Makinodan (Oak Ridge National Lab., Tenn.). Transplantation Bull., 27: 87-90(Jan. 1961).

The inconsistent antibody response by the long-term survivors of isologous bone marrow (IBM)-treated mice was in contrast to past studies indicating a completely normal immune mechanism. The following explanations for the extreme variation in response observed in the 4 strains reported here are possible: (a) irreversible damage to the host's immune system by the lethal irradiation and failure of the grafted donor tissue to effect a recovery; or (b) a genetic alteration in either the grafted isologous hematopoietic cells or the host tissue, sufficient to simulate a homologous donor-host situation and consequently to lead to an immunologic disorder. To what extent these variables may influence the immune mechanism of IBM- and also the homologous fetal liver (HFL)- and homologous adult bone marrow (HBM)-treated animals is only speculative. In any event, it is apparent that transplantation of a compatible graft in the irradiated recipient does not necessarily connote a normal physiologic status. The inability to distinguish by gross histologic examination those animals that were poor responders in the HFL-treated mice suggests that future studies on immune status of irradiated chimeras be performed by the in vivo cell tissue culture techniques developed by Makinodan et al., rather than by utilizing the whole animal. In this manner, individual organs such as the spleen and lymph nodes could be tested individually and more quantitative estimations be made on their functional immune status relative to the normal. (auth)

8575 MODIFIED HOMOLOGOUS DISEASE FOLLOWING TRANSPLANTATION OF PARENTAL BONE MARROW AND RECIPIENT LIVER INTO IRRADIATED F_1 MICE. G. Cudkowicz and G. E. Cosgrove (Oak Ridge National Lab., Tenn.). Transplantation Bull., 27: 90-4(Jan. 1961).

Bone marrow of C57BL donor mice incubated in vitro with (C57BL × 101)F_1 liver cells induced mortality in only 18% of lethally irradiated (C57BL × 101)F_1 recipients, whereas when incubated with C57BL liver cells or injected without preincubation, C57BL bone marrow killed 83 and 62%, respectively, of such recipients within 150 days. It is assumed that the mortality in lethally irradiated F_1 recipients of parental bone marrow resulted from a graft-vs.-host immunological reaction. Therefore the reduction of mortality by preincubation of the bone marrow with recipient liver is attributed to depression of the immunological reactivity of the marrow. No explanation can be given at the present time as to the mechanism by which the immunological reactivity of C57BL bone marrow may have been reduced; however, the phenomenon was recognized only when the liver cells were removed from the incubation mixtures before implantation, presumably because the F_1 liver contained immunologically competent cells that reacted against the parental bone marrow antigens. That donor hematopoietic elements survived the incubation in a functional state is indicated by their ability to protect and repopulate irradiated recipients and by the presence of donor type circulating erythrocytes in these animals. (auth)

8576 RADIATION LEUKEMOGENESIS: A QUANTITATIVE ANALYSIS OF THE PROBLEM. Eugene P. Cronkite. p.92-103 of Current Concepts in Leukemia. Report of the Thirty-fourth Ross Conference on Pediatric Research. Denman Hammond, ed. Columbus, Ohio, Ross Laboratories, 1960.

It is pointed out that the carcinogenic effects of radiation have been known since shortly after Roentgen's discovery of x rays but that this disease is only a fraction of the total radiation problem that also includes life-shortening, decreased fertility, cataracts, and genetic diseases induced by mutations due to irradiation. Lewis' hypothesis of linear dose-effect relation in human radiation leukemogenesis is discussed. Results are summarized from studies on the incidence of leukemia in populations in Hiroshima and Nagasaki following atomic-bomb exposure; the incidence of leukemia in patients with spondylitis treated with x-ray therapy; the incidence of leukemia in children whose mothers had received x-ray pelvimetry during pregnancy; the incidence of cancer in children undergoing thymic irradiation in very early life; and the incidence of leukemia presumably due to exposure to x ray, radium, thorium, or I^{131} therapy. It is pointed out that all analyses of human radiation leukemogenesis are based on less than 500 well-documented cases of leukemia over a period of 60 years in a constantly changing environment. It appears that children of about ten years of age are more sensitive to development of radiation leukemia than older age groups. Theories of dose-response and threshold dose are discussed. The opinion is expressed that all radiation, however small the amount, carries some inherent calculated risk. In the discussion Dr. Edward B. Lewis states that it is a fallacy to assume that background radiation causes no diseases. Background radiation can contribute to perhaps 10% of all natural genetic disease and may also account for 10% of the malignant diseases. (C.H.)

Radiation Sickness

8577 (AMRL-433) REDUCTION IN RADIATION LETHALITY BY CHEMICAL MIXTURE AND BONE MARROW IN MICE. J. A. Gantz and R. I. H. Wang (Army Medical Research Lab., Fort Knox, Ky.). May 24, 1960. 11p. Project No. 6X64-14-001-01.

Using a mixture of three radioprotective chemicals, 0.35 mg of serotonin, 0.85 mg of AET, and 2.0 mg of MEA (dose expressed as free base per mouse), the $LD_{50/30\text{-day}}$

exposure value was increased from 680 to 1500 r x radiation given to female C_3H mice. Combining this mixture preirradiation with isologous marrow postirradiation, 91% 30-day survival was obtained at 1700 r, and 52% 30-day survival at 2000 r x radiation. Seven deaths occurred within 30 min of the injection of chemicals to 212 animals (3.3%), and one additional death was attributed to air embolis. All other deaths were considered radiation induced. It is suggested that effective protection with minimal toxicity is through synergistic chemical action, plus the additive action of marrow, although the mechanisms remain unknown. (auth)

8578 (JPRS-4345(p.16-22)) ENZYMATIC FORMATION OF HEMOLYSINS IN HEPATIC TISSUE IN RADIATION SICKNESS. V. N. Benevolenskiĭ (Benevolenskiy). Translated from Voprosy Med. Khim., 6: 480-3(1960).

In liver of x-irradiated rats (dose 1000 r) an increase in the hepatic ferment activity occurs 1 hr after exposure and is observed for a period of 2 to 3 days prior to the animals' death. A lesser increase in activity of similar ferments occurs in the initial period of post-mortem autolysis of normal rat liver. In the later stages of autolysis, the activity of these ferments sharply decreases. (auth)

8579 (JPRS-4345(p.23-9)) ON THE ROLE OF THE LIVER IN THE METABOLISM OF URIC ACID AND ALLANTOIN IN RADIATION SICKNESS. T. A. Fedorov and V. P. Fedotov. Translated from Voprosy Med. Khim., 6: 497-500(1960).

In experiments on dogs poisoned with polonium and irradiated with γ rays, hepatic retention of uric acid and hepatic excretion of allantoin was increased. The oxidative capacity of the liver is noticeably decreased in the terminal period of radiation sickness. (auth)

8580 (TT-915) THE EFFECT OF STARVATION ON GLYCOGEN METABOLISM OF THE LIVER IN RADIATION SICKNESS OF ANIMALS. G. P. Toropova. Translated by G. Belkov from Voprosy Pitaniya, 17: 50-4(1958). 10p.

The liver of irradiated rats accumulates less glycogen than that of control animals having free access to food. This corresponds to data in the literature. The decrease in the content of glycogen in the liver of irradiated rats is determined by the extent to which feeding is disrupted. This disruption, in turn, depends on the magnitude of the dose applied and the stage of the illness. When rats are killed without food in their stomachs after having been reared on equal amounts of food or when they have been completely starved, the irradiated rats contain more glycogen in the liver than control animals. (auth)

8581 CHANGES IN THE SECRETION AND PROPERTIES OF GASTRIC JUICE AFTER HISTAMINE IN ACUTE IRRADIATION DISEASE. Swiatosław Ziemlański. Acta Phys. Polon., 11: 57-63 (1960). (In Polish)

The experiments concerned dogs with surgical gastric fistulas, which were treated with a total dose of 800 r of x rays. Histamine was given in single subcutaneous 0.025 mg/kg doses. In acute irradiation disease these injections were followed by increased secretion of gastric juice and hydrochloric acid over the first 4 to 5 days postirradiation. The highest rise in the secretion of gastric juice (average from 68 to 87 ml) and hydrochloric acid (average from 0.310 to 0.401 g %) was recorded on the second day after irradiation. After 5 to 6 days, this secretion of gastric juice gradually diminished and attained a very low level (average 10.5 ml, mixed with mucus and blood). There was a concomitant fall in free hydrochloric acid, the secretion of which stopped altogether 1 to 2 days before the animal's death. The level of pepsin increased in the first day after irradiation (on the average by 42%) and over subsequent days to almost four times the original value at the end of life. Survival time of the dogs was 11 to 13 days. Autopsy revealed numerous extravasations and erosions of gastric and intestinal mucosa. The initial increase in gastric juice and hydrochloric acid secretion is attributed to the summing of the effects of endogenous and exogenous histamine. Subsequent diminution of that secretion is due to the destruction of producing cells. Increased proteolytic effects of the gastric juice may be attributed to desquamation of the cells of the gastric mucosa. (auth)

8582 THE BEHAVIOUR OF VASCULAR REACTIONS IN ACUTE IRRADIATION DISEASE. Jan Ryżewski. Acta Phys. Polon., 11: 197-221(1960). (In Polish)

Acute experiments were made with cats, and chronic experiments with dogs. The acute experiments numbered 377 and concerned 65 cats of either sex and different weights in urethan anesthesia. Another 22 cats were used for 65 control experiments. The cats received a total dose of 1500 r from a therapeutic x-ray unit. The conditions were: distance, 60 cm; 0.5 mm copper filter; 160 kv; 20 ma; 29 r/min. The cats were examined on the third day after irradiation, when the irradiation disease picture was developed. Vascular reflexes from the interoceptors of the carotid sinus were investigated after Heymans's method, reflexes from the interoceptors of spleen and intestinal loop vessels after Czernigowski's method, and reflexes from interoceptors of hind-leg vessels after the author's method. Adrenaline, noradrenaline, serotonin, acetylcholine, potassium chloride, and lactic acid were used to stimulate interoceptors. To stimulate the proximal section of the sciatic nerve and peripheral part of the splanchnic nerve, electric current was used—3 to 6 volts, 20 ma, 20 sec. Furthermore, arterial blood pressure was measured in irradiated cats after intravenous administration of adrenaline, noradrenaline, serotonin, acetylcholine, or histamine. Experiments were also made with cats poisoned with phentolamine, atropine, or pendiomid. The experimental material was analyzed statistically. Chronic experiments numbered 165 and concerned 6 dogs. Before irradiation, the dogs were operated upon after the author's method to enable blood pressure to be measured by intravascular technique, and subsequently standards of arterial blood pressure reaction to adrenaline, noradrenaline, serotonin, acetylcholine, and histamine were determined. In the experiments, the dogs received a total dose of 800 r from a therapeutic x-ray unit. Conditions were: distance, 80 cm; 0.5 mm Cu filter; 160 Kv; 20 ma; 21 r/min. Arterial blood pressure reaction to the above neurohormones was investigated in the irradiated dogs daily. Experiments with dogs poisoned with phentolamine or pendiomid were also carried out. The experiments referred to showed ionizing radiation to reduce considerably reflexes from vascular chemoreceptors to neurohormones, potassium chloride, and lactic acid. In irradiated cats, pressor reflexes from carotid sinus mechanoreceptors were diminished, and so were pressor reflexes to electric stimulation of the sciatic and splanchnic nerves. Neurohormones, such as adrenaline and noradrenaline, caused in cats and dogs lower-than-standard effects. Depressor effects of serotonin were in irradiated and nonirradiated cats equal in strength. In dogs, on the other hand, pressor effects of serotonin diminished in strength with the progress of irradiation disease. Pressure fall evoked by acetylcholine and histamine was the same in irradiated and nonirradiated cats and dogs, but of considerably longer duration in irradiated animals. Phentolamine diminished

pressor effects of adrenaline in irradiated cats and dogs, and also weakened in dogs the pressor effects of serotonin. Atropine and phentolamine increased in irradiated cats and dogs pressor effects of adrenaline and noradrenaline, and pressor effects of serotonin in dogs. It was concluded that in acute irradiation disease the adrenergic part of the autonomic nervous system, first of all sensory and vasomotor terminals, is injured. Also, preserved vasomotor reflexes, even though weakened, enable in this disease an influence to be exerted on the functional efficiency of the circulatory system. (auth)

8583 SOME OBSERVATIONS ABOUT EFFECTS OF ISOLOGOUS SPLENIC CELLS ON LETHALLY IRRADIATED MICE. J. Rerabek (Academy of Agricultural Sciences, Prague, Czechoslovakia). Experientia, 16: 557-8(1960). (In English)

X-irradiated CBA mice (dose of 900 r) were injected intravenously with 40×10^6 isologous nucleated splenic cells (ISpC). The mortality decreased in comparison with the controls. Respiration and aerobic glycolysis of intestinal mucosa and spleen of the ISpC mice remained near normal, although at the same time the blood picture indicated radiation damage. The initial anemia was more rapidly normalized than the leucopenia. At the end of the observation time, the relative leucopenia and the granulocytosis reverted to almost normal. The graying of the animals caused by damage of the hair follicles remains unaffected by the ISpC treatment. (tr-auth)

CHEMISTRY

General and Miscellaneous

8584 (CF-59-8-43) STUDY OF DISPERSANT AGENTS FOR THORIUM OXIDE. L. C. Bate and G. W. Leddicotte (Oak Ridge National Lab., Tenn.). Aug. 7, 1959. 5p.

A preliminary study of dispersing agents for thorium oxide was completed and several of the dispersants have possible uses. Also many of the industrial dispersing agents tested are not usable with thorium oxide due to induced behavior causing balling and caking. The effects of nitric acid concentration were observed to also effect each dispersing agent. (auth)

8585 (NP-9721) HIGH-TEMPERATURE SYNTHESIS OF NEW, THERMALLY-STABLE CHEMICAL COMPOUNDS. Quarterly Progress Report No. 3, Covering Period September 14 to December 14, 1960. L. C. Bratt, D. L. Chamberlain, and C. W. Marynowski (Stanford Research Inst., Menlo Park, Calif.). Dec. 27, 1960. 13p. Contract AF33(616)-7245.

The program involves two concurrent research areas, one dealing with phosphonitrilic compounds and the other with perfluorocarbon compounds. Several electronically activated reactions were conducted for the purpose of synthesizing phosphonitrilic polymers from simple starting materials containing combinations of the elements P, N, S, O, and H. The plasma-jet flash pyrolysis technique for the attempted conversion of simple halofluorocarbons to polymeric fluoroorganics was applied in a run in which a relatively inert quench medium was used. A number of routes to difluoroacetylene are being studied. (W.L.H.)

8586 (NYO-9560) MAGNETIC INVESTIGATIONS OF SPIN-FREE COBALTOUS COMPLEXES. V. TETRAAZIDO AND TETRA-CYANATO COBALTATE(II) IONS. F. Albert Cotton and Margaret Goodgame (Massachusetts Inst. of Tech., Cambridge. Dept. of Chemistry). Nov. 7, 1960. 11p. Contract AT(30-1)-1965.

The electronic spectra between 0.4 and 2.0 μ and the magnetic susceptibilities between 70 and 300°K of the tetraazido- and tetraiso-cyanatocobaltate (II) ions, $[Co(N_3)_4]^{2-}$ and $[Co(NCo)_4]^{2-}$, are reported. These results are interpreted using ligand field theory to show the following structural and electronic features of these complex ions: (1) they are tetrahedral; (2) in $[Co(NCo)_4]^{2-}$ it is almost certainly the nitrogen atoms that are bound to the Co(II); (3) $-NCo^-$ lies toward the stronger end in the spectrochemical series but toward the weaker end in the nephelauxetic series relative to N_3^-; (4) the metal-ligand bonds possess covalent character; and (5) the spin-orbit coupling constants of Co(II) in these complexes are 65 to 85% of the free-ion value. (auth)

8587 (TID-6912) ISOTOPE EXCHANGE AND ISOTOPE EFFECTS IN THE REACTIONS OF ORGANOLITHIUM COMPOUNDS. Technical Progress Report. Robert West and William Glaze (Wisconsin. Univ., Madison). Oct. 1960. 11p. Project No. 18. Contract AT(11-1)-64.

A study was made of the kinetic isotope effect in a typical reaction of an organolithium compound. The infrared spectra of organolithium compounds were investigated. A method for the direct preparation of vinyllithium compounds is reported. A series of solid complexes of alkyllithium compounds was prepared with lithium hydrides. (W.L.H.)

8588 (TID-11018) RESEARCH ON THE SYNTHESIS OF CERTAIN HETEROCYCLIC AND PHOSPHORUS-CONTAINING COMPOUNDS. Final Report Covering the Period Feb. 1, 1958 through June 1, 1960. Pete D. Gardner (Texas. Univ., Austin). Oct. 3, 1960. 21p. Contract AT-(40-1)-1288.

Results are summarized of investigations on the synthesis of organophosphorus compounds and ethers. The purity of solid substances was estimated from melting-point data; whereas the purity of liquids was determined by gas chromatography. (W.L.H.)

8589 (TID-11333) MECHANISMS OF ACID-BASE CATALYSIS AND STUDIES IN DEUTERIUM OXIDE AS SOLVENT. Progress Report for Period, December 1959 through December 1960. F. A. Long (Cornell Univ., Ithaca, N. Y.). Dec. 21, 1960. 8p. Contract AT(30-1)-1725.

A detailed re-examination was made of the theory of deuterium solvent isotope effects. The approach was through the specific problem of ionization constants of weak acids in mixed H_2O-D_2O solvents. General equations were developed and then an examination was made of the assumptions which lead to various limiting formulations. The base catalyzed exchange of acidic hydrogen of phenylacetylene was studied with H^3-labeled material. A study was completed on the base catalyzed keto-enol transformation of 2-acetylcyclohexanone in the solvents H_2O and D_2O. A study is reported of ionization constants of weak acids in the solvents H_2O and D_2O, with emphasis on systems involving hydrogen bonding. (W.L.H.)

8590 (CEA-tr-R-1033) SYNTHESE DES COMPOSES ORGANIQUES MARQUÉS AU CARBONE RADIOACTIF. (Synthesis of Organic Compounds Labeled with Radioactive Carbon). I. A. Korshunov, N. F. Novotorov, R. V. Amenitskaya (Amenitskaia), I. S. (C.) Okrokova, N. A. Pestunovitch (Pestounovitch), V. N. Dubovskaya (Doubovskaia), M. R. Leonov, and V. M. Glasov. Translated into French from Radiokhimiya, 1: 728-33(1959). 19p.

Methods are given for preparation of certain aliphatic and aromatic hydrocarbons, aldehydes, ketones, and ethylene oxide starting with alcohols containing C^{14}. The procedures include simultaneous preparation of several labeled compounds with subsequent separation and purification, and recycling of unreacted reagents. Catalyst selection for

certain compounds was studied. The internally filled counter and scintillation counter methods of analysis were used. An equation was developed for calculation of specific activity of labeled organic compounds. (T.R.H.)

8591 (JPRS-4336) ION-EXCHANGE MEMBRANES—THE APPLICATION OF ION-EXCHANGE MEMBRANES IN CHEMICAL TECHNOLOGY. V. S. Titov. Translated from Plasticheskie Massy, No. 1, 55-9(Jan. 1960). 15p.

A review of the applications of ion-exchange membranes in chemical technology is presented. It is noted that the most extensive and promising use of ion-exchange membranes is as active partitions for electrolyte baths in electrochemical processes. Multicompartment electrodialyzers are presently being used in the process of freshening sea water. (J.R.D.)

8592 BONDING URANIUM 238. NEW TECHNIQUE ELIMINATES OXIDATION PROBLEM BY COMBINING ABRASION AND ADHESIVE COATING STEPS INTO ONE OPERATION. Raymond F. Wegman and Michael J. Bodnar (Picatinny Arsenal, Dover, N. J.). Adhesives Age, 3p. (June 1960).

Successful bonding of U^{238} was accomplished by removal of the oxide layer and application of the adhesive without exposing the uranium to air. In this method the metal was manually abraded in a pool of liquid adhesive. Bond strengths of approximately 1200 psi were obtained. The bonds formed by this new method withstood storage for one month at 160°F and 12 months at temperatures ranging from 25 to 95°F without a loss of tensile strength. A modified bisphenol A-based epoxy and a polyurethane type adhesive were found to be most satisfactory for the bonding. Other studies using variations of this method are discussed. (M.C.G.)

8593 TRITIUM GAS EXPOSURE LABELING. K. E. Wilzbach (Argonne National Lab., Ill.). Atomlight, No. 15, 1-3(Dec. 1960).

Activities in the range of 1 to 100 mc/g were generally obtained by exposure of organic compounds to curie amounts of H^3 for several days. In general, the fraction of H^3 incorporated per day decreased as the molecular weight and complexity of the molecule increased. The formation of labeled by-products proved to be one of the major problems in the use of the gas exposure method. Acceleration of the process by the use of ultraviolet light, external γ radiation, or an electrical discharge was investigated. It was found by Mottlau that the addition of argon to H^3 in the labeling of n-hexane increased the amount of H^3 incorporated into the parent compound. (M.C.G.)

8594 SOME EXPERIENCE WITH LABELING SUGARS BY TRITIUM GAS EXPOSURE. Robert K. Crane, George R. Drysdale, and Kenneth H. Hawkins (Washington Univ. Medical School, St. Louis). Atomlight, No. 15, 4-6(Dec. 1960).

A group of compounds that are analogs of D-glucose, but which cannot be metabolized by animal tissues, were H^3-labeled using the gas exposure method. Each compound was exposed, in amounts ranging from 0.2 to 1.0 g, to pure H^3 gas at partial pressures of 100 to 150 mm Hg for a period of 14 to 21 days. During exposure there was a browning of the compounds which increased with time. The specific activities of the H^3-labeled sugars are given. These compounds seemed to act biologically in exactly the same way as their nonradioactive counterparts. (M.C.G.)

8595 SYNTHESIS OF ^{35}S-MARKED S-DITHIOPROPYLTHIAMINE. Bernard Gauthier, André Uzan, and Louis Pichat (Centre d'Etudes Nucleaires, Saclay, France). Bull. soc. chim. France, 1559-60(1960). (In French). (CEA-1589)

S^{35}-labeled S-dithiopropylthiamine was prepared by the action of propyl thiosulfate, in alkaline solution, on thiamine hydrochloride labeled with S^{35} having a specific activity of 74.4 μc/mg. The product obtained had an activity of 50.2 μc/mg. (auth)

8596 THE MECHANISM OF THE CARBONYL ELIMINATION REACTION OF BENZYL NITRATE. KINETIC ISOTOPE EFFECTS AND DEUTERIUM EXCHANGE. Erwin Buncel and A. N. Bourns (McMaster Univ., Hamilton, Ont.). Can. J. Chem., 38: 2457-66(Dec. 1960).

The carbonyl elimination reaction ($E_{CO}2$) of benzyl nitrate was investigated to distinguish between the concerted and carbanion mechanisms. A deuterium exchange experiment resulted in a very small amount of deuterium pickup. The nitrogen isotope effect, k_{14}/k_{15}, associated with formation of the nitrite ion was found to be 1.0196 ± 0.0007 at 30°C. The two results taken together exclude the formation of a carbanion intermediate but are consistent with a concerted mechanism. Benzyl-α-d_2 nitrate was prepared and the rate of its carbonyl elimination reaction compared with that of the undeuterated compound. The deuterium isotope effect was 5.04 ± 0.25 at 60°C. The significance of the magnitude of the nitrogen and deuterium isotope effects and of their interrelationship with the Hammett reaction constant ρ is discussed in terms of the nature of the transition state and a comparison is made with other E2 elimination reactions. (auth)

8597 ORGANIC DEUTERIUM COMPOUNDS. XXIII. SYNTHESIS OF DEUTERATED OLEFINS. D. Kovachic and L. C. Leitch (National Research Council, Ottawa). Can. J. Chem., 39: 363-74(Feb. 1961).

The synthesis of some deuterated ethylenes, propylenes, butenes, and pentenes is described. Homolytic addition of hydrogen bromide and deuterium bromide to allene and some deuteroallenes was investigated and found to give 2-bromopropylene and deutero-2-bromopropylenes rather than the 3-bromo isomers. The preparation of 3-bromopentadeuteropropene by the allylic bromination of hexadeuteropropene is described. Bromotrichloromethane and 1,3-butadiene gave, under homolytic conditions, trans-5,5,5-trichloro-1-bromo-2-pentene, which was debrominated to a mixture of 5,5,5-trichloropentenes. The latter was then dechlorinated to 1-pentene, which contained some 2-pentenes. Hexadeuterobutadiene reacted similarly to give the corresponding deuterated compounds. (auth)

8598 THE PREPARATION OF THE TITANYL OXALATES OF DIVALENT METALS AND A PHYSICO-CHEMICAL STUDY OF THEIR THERMAL DECOMPOSITION. B. V. Strizhkov, A. V. Lapitskiĭ, L. G. Vlasov, and A. I. Tsvetkov (Moscow State Univ., U.S.S.R.). Doklady Akad. Nauk, S.S.S.R., 133: 1347-9(Aug. 21, 1960). (In Russian)

The titanyl oxalate complex is obtained by adding a concentrated oxalic acid solution with agitation to an aqueous solution of titanium tetrachloride (0.2 to 0.3 g titanium/ml). On adding an aqueous solution of the divalent salt, white precipitates with the following composition were obtained: $BaTiO(C_2O_4)_2 \cdot 4H_2O$, $SrTiO(C_2O_4)_2 \cdot 5.5H_2O$, $PbTiO(C_2O_4)_3$ $4H_2O$, and $CaTiO(C_2O_4)_2 \cdot 5H_2O$. Some acetone was added to the aqueous titanium chloride to obtain the calcium salt. Thermogravimetric analyses of this salt showed that the water of crystallization was given off first at 150 to 250°C, then the oxalate groups decomposed with the evolution of CO_2 at 320 to 360°C, and finally the metatitanate was formed at about 800°C. The metatitanates have a perov-

skite structure. The specific gravities of the metatitanates of calcium, barium, strontium, and lead are listed. (TTT)

8599 CALCULATION METHODS FOR FRACTIONATING COLUMNS. B. Brigoli (Centro Informazioni Studi Esperienze, Milan). Energia nucleare (Milan), 7: 845-8 (Dec. 1960). (In English)

Analytical methods are proposed for the calculation of ideal distillation columns both of plate or packed type. The equations presented are valid in the whole concentration range and for any value of separation factor of a binary mixture. Calculation examples are given for the system H_2O-D_2O. (auth)

8600 STUDY ON SOME FLUORINATION TECHNIQUES. DESCRIPTION OF A PLANT FOR THE PRODUCTION OF FLUORINE AND FLUORINE HALIDES. G. Camozzo and S. Pizzini (Centro di Studi Nucleari, Ispra, Italy). Energia nucleare (Milan), 7: 849-61(Dec. 1960). (In English)

A plant for the production by electrolysis of fluorine and fluorine halides is described. The electrolytic cell operates at high temperature and has a capacity of about 700 g/day of fluorine. (auth)

8601 RADIOCHEMICAL TRACING OF FLUID CATALYST FLOW. R. L. Hull and A. E. Von Rosenberg (Humble Oil and Refining Co., Baytown, Tex.). Ind. Eng. Chem., 52: 989-92(Dec. 1960).

A catalyst velocity of 11 fps in a pilot unit transfer line was determined by injection of catalyst tagged with zirconium–niobium-95. Similar injections have illustrated mixing patterns in the reactor proper. The examples presented of the types of data which may be obtained demonstrate the unique ability of the tracer technique to provide vital information concerning the effects of operating conditions and structural designs on solids-mixing patterns in fluidized systems. (auth)

8602 AGGLOMERATE MIXING. Raymond H. Comyn, Ira R. Marcus, and Robert E. McIntyre (Diamond Fuze Labs., Ordnance Corps, Washington, D. C.). Ind. Eng. Chem., 52: 995-8(Dec. 1960).

An agglomerate method was developed for blending fine powders into a homogeneous mixture. This method depends on forming very small agglomerates of the particles in a liquid suspension. The composition of the agglomerates remains constant in subsequent mixing and handling operations. The performances of a number of agglomerate mixtures are discussed, including compositions intended for use as time delays, delay igniters, and heat powders in ordnance devices. (auth)

8603 FORCE CONSTANTS OF THE URANYL ION BY WILSON'S F-G MATRIX METHOD. K. V. Narasimham (Madras Inst. of Tech., Chromepet, Madras, India). Indian J. Phys., 34: 432-3(Sept. 1960). (In English)

The force constants of the UO_2^{2+} ion in cesium uranyl nitrate were calculated using Wilson's normal coordinate treatment for both bent and linear ion structures. A table of the force constants in dynes/cm is given for O–U stretching, interaction between the two bonds, O–U–O bending, and interaction between the bond and the angle. (D.L.C.)

8604 INVESTIGATIONS ON CHEMICAL PROPERTIES OF FRANCIUM BY MEANS OF Fr^{212}. A. K. Lavrukhina, A. A. Posdnyakov, and S. S. Rodin (Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, Moscow). Intern. J. Appl. Radiation and Isotopes, 9: 34-48(Dec. 1960). (In English)

A generalization of work on the chemistry of francium carried out by means of Fr^{212} is presented. Methods for recovery and isolation of francium isotopes are considered. Co-precipitation of Fr^{212} with various precipitates is studied. Most extensive are studies on co-precipitation of francium, cesium, and rubidium with di- and tri-heteropoly acids. Volatilities of tracer quantities of francium and cesium chlorides are studied as a function of temperature and time of heating. Detailed investigation is made on the sequence of adsorption of francium, cesium, and rubidium cations on KU-1 and KU-2 cation exchangers from electrolytic solutions of different concentrations. A new method of rapid and effective isolation of francium from cesium and rubidium is worked out. The possibility of using Fr^{223} for the determination of actinium in uranium ores is shown. (auth)

8605 THE INCORPORATION OF IODINE-132 INTO ORGANIC COMPOUNDS. J. Robson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Intern. J. Appl. Radiation and Isotopes, 9: 126-9(Dec. 1960). (In English)

Two methods are given for labeling organic compounds, especially unsaturated oils and waxes, with I^{132}. In one method, an aqueous solution of I^{132} separated from Te^{132} is heated with an oil or a wax until the water is removed, and in the other method, a gaseous stream of I^{132} is passed through the compound to be labeled. A wide variety of compounds was labeled with both methods and tested for permanent labeling. (D.L.C.)

8606 THE PREPARATION OF KRYPTON-85–CLATHRATE COMPOUNDS. E. J. Wilson and J. D. H. Hughes (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Intern. J. Appl. Radiation and Isotopes, 9: 129-30(Dec. 1960). (In English)

It is possible to prepare a quinol clathrate of krypton with 80 to 90% occupancy of the available sites if 25% EtOH–75% water is used as the solvent. Two such preparations employing ~0.2% Kr^{85} in krypton were stored in stoppered bottles containing undried air; the krypton content dropped by ~10% in the first 3 to 4 months and by another 5 to 10% in the next 2 months. No further loss was observed in the next 28 months, but on destructive analysis a mixture of H_2, CO, CO_2, CH_4, and Kr was evolved. An inactive sample under similar conditions remained stable. The initial krypton loss and the formation of the other gases are attributed to the effect of β radiation on quinol in moist air, and the subsequent reduction in krypton loss may be due to the formation of a protective layer of solid decomposition products. An attempt to stabilize the clathrates by incorporation into a plastic matrix was only partially successful. (D.L.C.)

8607 FORMATION OF THE INTERMEDIATE METHOXYCHLOROMETHYLENE IN THE REACTION DICHLOROMETHYL METHYL ETHER WITH BASE. Jack Hine, Robert J. Rosscup, and Donald C. Duffey (Georgia Inst. of Technology, Atlanta). J. Am. Chem. Soc., 82: 6120-3 (Dec. 5, 1960).

Comparisons of the rate of reaction of potassium isopropoxide with $CHCl_2OCH_3$ and $CDCl_2OCH_3$ showed a marked deuterium kinetic isotope effect ($k_H/k_D = 5.4 \pm 2.2$). This shows that the reaction involves an initial α-dehydrochlorination to give the intermediate methoxychloromethylene. In other experiments, potassium thiophenoxide was found to be about as reactive as potassium isopropoxide toward dichloromethyl methyl ether. (auth)

8608 SECONDARY HYDROGEN ISOTOPE EFFECTS ON DEOXYMERCURATION. Maurice M. Kreevoy and

Leroy T. Ditsch (Univ. of Minnesota, Minneapolis). J. Am. Chem. Soc., 82: 6127-9(Dec. 5, 1960).

The ratio k_H/k_D for acid cleavage of $CH_3OCH_2CH_2HgI$ and its 1,1,2,2-tetradeuterio analog is 1.06 ± 0.02. This isotope effect, combined with the known vibrational frequencies of the substrates and metal-olefin complexes, precludes the extensive participation of a mercuric-olefin complex in the transition state resonance hybrid. The small isotope effect also tends to preclude extensive carbonium ion character in the transition state. It can be accommodated by a substrate-like model of the transition state in which the methylene-oxygen bond is breaking. (auth)

8609 THE ACTIVATION OF MOLECULAR HYDROGEN BY PLATINUM. Alvin I. Krasna (Columbia Univ., New York). J. Am. Chem. soc., 83: 289-91(Jan. 20, 1961).

The activation of molecular hydrogen by platinum was studied by means of the ortho-para hydrogen conversion and the exchange reaction between hydrogen and deuterium oxide. The reaction between hydrogen and water was shown to be a gas-phase reaction. With 100% D_2O as solvent, there was no para hydrogen conversion and D_2 was produced in greater quantities than HD. The data indicate that platinum catalyzes a homolytic split of the hydrogen molecule. The mechanism of the platinum-catalyzed activation of hydrogen was compared with the enzyme catalyzed reaction. (auth)

8610 FLUORINE 18 EXCHANGE BETWEEN URANIUM HEXAFLUORIDE AND METAL FLUORIDES. Irving Sheft, Herbert H. Hyman, Richard M. Adams, and Joseph J. Katz (Argonne National Lab., Ill.). J. Am. Chem. Soc., 83: 291-4(Jan. 20, 1961).

Uranium hexafluoride has been reported to form a compound 3 $NaF \cdot UF_6$ with sodium fluoride. The fluorine exchange between UF_6 and NaF was undertaken to further investigate the nature of this addition compound. With the radioactive fluorine F^{18} in either the NaF or UF_6, exchange experiments indicate complete exchange for a compound of the composition 2 $NaF \cdot UF_6$. In some experiments with more than one mole of UF_6 for three moles of NaF all the UF_6 was absorbed, and the extent of exchange indicated the compound 2 $NaF \cdot UF_6$ was formed. Essentially no exchange occurs when gaseous UF_6 is passed through NaF^{18} at temperatures above which the solid addition compound forms. No compound was formed, and essentially no exchange occurred, between UF_6 and LiF, KF, ZrF_4, and AgF. No compound was identified in the case of CaF_2, but a significant amount of exchange was noted. (auth)

8611 ACID-BASE EQUILIBRIA IN SOLVENT MIXTURES OF DEUTERIUM OXIDE AND WATER. E. A. Halevi, F. A. Long, and M. A. Paul (Cornell Univ., Ithaca, N. Y. and Harpur Coll., Endicott, N. Y.). J. Am. Chem. Soc., 83: 305-11(Jan. 20, 1961).

The dependence of the relative ionization constant of a weak acid on the atom fraction n of deuterium in a mixed deuterium oxide-water solvent is treated from a general point of view, with particular consideration of medium effects caused by the change in solvent. Various limiting formulations for comparison with experiment can be derived from the general equations, depending on the particular simplifying assumptions that are made. The Gross-Butler formulation, characterized by a cubic term in the denominator, results from assuming monohydrated protons and deuterons and additionally ignoring all medium effects, i.e., neglecting free energies of transfer of the relevant species from one medium to another. A "linear" formulation (with a first-order term in the denominator) results if one postulates nonspecific solvation for the protons and deuterons and again neglects free energy of transfer. Finally a "medium effect" formulation can be derived by assuming that the entire effect is due to free energy of transfer, i.e., that exchange fractionation is negligible. Comparison of these limiting formulations with experimental data for both ionization constants and rate coefficients of acid catalyzed reactions reveals that quite respectable fits may be obtained with each of them. However, for reactions that have K_H/K_D or k_D/k_H values close to unity the Gross-Butler formulation fits considerably less well than the other two. Since the most likely actual situation is some superposition of contributions from medium effects and exchange fractionation, it seems highly doubtful that acid-base studies in mixed solvents will permit unambiguous conclusions about the state of solvation of the protons. Furthermore, in view of the likelihood that medium effects are of consequence, it is doubtful whether rate studies in the mixed solvents will permit choices to be made among kinetic mechanisms, a conclusion which was recently also reached by Gold from a different line of reasoning. (auth)

8612 THE PREPARATION OF THE VOLATILE HYDRIDES OF GROUPS IV-A AND V-A BY MEANS OF AQUEOUS HYDROBORATE. William L. Jolly (Univ. of California, Berkeley). J. Am. Chem. Soc., 83: 335-7(Jan. 20, 1961).

By the dropwise addition of an alkaline solution of hydroborate and either arsenite, antimonite, germanate, or stannite to aqueous acid, good yields of either arsine, stibine, germane, or stannane, respectively, were obtained. Small amounts of diarsine, digermane, and the heretofore unknown distannane formed with the arsine, germane, and stannane, respectively. No silane was obtained by a similar procedure using a solution of sodium silicate, and only traces of phosphine were obtained by similar procedures involving phosphite and hypophosphite. Distannane readily decomposes into the elements at room temperature. The infrared absorption spectrum of solid distannane was determined and a partial frequency assignment was made. (auth)

8613 STABILITY RELATIONSHIPS AMONG THE RARE EARTH DIPICOLINATES. Ingmar Grenthe (Pennsylvania State Univ., University Park). J. Am. Chem. Soc., 83: 360-4(Jan. 20, 1961).

Stepwise stoichiometric formation constants were determined for the complexes between copper, yttrium, the rare earths, and the dipicolinate ion. The measurements were made in an aqueous perchlorate medium of the ionic strength μ = 0.5M at a temperature of 20°. (auth)

8614 ON THE REACTIVITY OF URANOURANIC OXIDE. V. ON THE RELATION BETWEEN REACTIVITY OF URANOURANIC OXIDES AND THE CONDITION OF THE PREPARATION. Rokuo Ukazi (Osaka Metal Ind. Co.). J. Atomic Energy Soc. Japan, 2: 731-5(Dec. 1960). (In Japanese)

The conditions of precipitating ammonium diuranate (ADU) and uranium peroxide (UPO) from uranyl nitrate (UNH), the temperature of thermal decomposition, and the rate and duration of heating were studied in order to estimate the reactivity of uranouranic oxide, U_3O_8 (I), (II), and (III) which was prepared from UNH, ADU, and UPO. The concentration of uranyl ion, speed of addition of precipitant, stirring condition, etc., had some effect on the specific surface area of U_3O_8 (II) and (III), but almost no effect on the width of x-ray-diffraction spectra of these oxides. The high reactivity of U_3O_8 (I) prepared by rapid heating may be due to the formation of amorphous UO_3 (I) during thermal decomposition of UNH. The low chemical reactivity of U_3O_8

(III) prepared by very slow heating was also explained as the result of the formation of monoclinic crystalline UO_3 (III). (auth)

8615 STRUCTURE OF THE ISOBUTANE MOLECULE; CHANGE OF DIPOLE MOMENT ON ISOTOPIC SUBSTITUTION. David R. Lide, Jr. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 33: 1519-22(Nov. 1960).

The microwave spectra of 5 isotopic species of isobutane were measured and analyzed. The isobutane molecule is shown to belong to point group C_{3v}. The structural parameters determined by the substitution method are r(CC) = 1.525 A, ∢ CCC = 111.15°, r(CH) = 1.108 A (tertiary), r(CH) = 1.09 – 1.10 A (methyl), ∢ HCH = 107.5 – 109.5°. The structure is compared with that of other hydrocarbons, and it is suggested that a small difference exists between CC distances determined by microwave and electron diffraction methods. Accurate Stark measurements show that the dipole moment of $(CH_3)_3CD$ is 6.5% ± 0.9% higher than that of $(CH_3)_3CH$. (auth)

8616 EMISSION SPECTRUM OF TRIVALENT HOLMIUM IN THE SCHEELITE STRUCTURE. L. G. Van Uitert and R. R. Soden (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 33: 1532-4(Nov. 1960).

Fluorescent emission from holmium can be readily observed in a calcium tungstate host lattice under 3660-A excitation. There are at least eight excited states of holmium which fluoresce in the visible range caused by transitions to the $^5I_8$ ground state. These emission peaks show concentration quenching effects which appear to be from the development of exchange coupling. A number of emission peaks from holmium represent transitions which do not correspond to known absorption bands. These peaks are particularly prominent in the emission spectra at high concentrations of holmium. (auth)

8617 EQUILIBRIUM CONSTANT FOR ISOTOPE EXCHANGE IN AMMONIA FROM INFRARED SPECTRA. Llewellyn H. Jones (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 33: 1585-6(Nov. 1960).

All isotopic-exchange equilibria among the H and D ammonias can be derived from $K_1(NH_3 + NHD_2 = 2NH_2D)$ and $K_2(ND_3 + NH_2D = 2NHD_2)$. At high temperatures, $K_1 = K_2 = 3$, as determined by the symmetry numbers of the various species. To avoid the difficulties encountered in previous experiments, apparent absorption coefficients were used to determine the equilibrium coefficients. The absorption coefficients were determined on path lengths of the pure species (NH_3 and ND_3) at the same total pressure as in the Stedman experiment and giving the same peak optical density of that experiment. Using 50–50 mixtures of NH_3 and ND_3, values of 3 ± 0.5 were found for K_1 and K_2. The apparent discrepancy between Stedman's measurements ($K_1 = 0.62$ and $K_2 = 1.31$) and other results arises because the NH_2D and NHD_2 P and R branches of ν_2 overlap the NH_3 and ND_3 Q branches to some extent. The equilibrium constants are quite sensitive to small errors in concentration. For the equilibrium constants at room temperature, the calculated values of ~2.9 may be used quite safely. (B.O.G.)

8618 EQUILIBRIUM IN THE EXCHANGE OF TRITIUM BETWEEN AMMONIA AND HYDROGEN AND THE ZERO-POINT ENERGY DIFFERENCE BETWEEN NH_3 AND NH_2T. Joel R. Gutmann and Max Wolfsberg (Weizmann Institute of Science, Rehovoth, Israel and Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 33: 1594-5(Nov. 1960). (BNL-4879)

Ammonia and hydrogen were separately tritiated and an iron catalyst was used to equilibrate them with respect to their isotopic composition. Their specific activities were determined, to 2% accuracy, by gas counting with a G-M glass counter. The equilibrium distribution of H^3 between NH_3 and H_2 was measured at 516, 538, and 623°K. At the lower temperatures equilibrium is reached slowly. In this case, the most reliable method for obtaining $K = [(NH_2T)(H_2)]/[(NH_3)(HT)]$, the equilibrium constant, is the comparison of the H^3 transfer rates in the forward and backward direction of the reaction in nonequilibrium mixtures. The transfer rate $R(\rightarrow)$ of T from H_2 to NH_3 was determined by dividing the rate of specific activity decrease in hydrogen by its initial specific activity. The results were $R(\rightarrow)_{516} = (6.5 \pm 0.3)\ 10^{-3}\ min^{-1}$ and $R(\rightarrow)_{538} = (1.50 \pm 0.03)10^{-2}\ min^{-1}$. The rates of T transfer from NH_2T to H_2, $R(\leftarrow)_{516} = (1.8 \pm 0.1)10^{-1}\ min^{-1}$ and $R(\leftarrow)_{538} = (4.4 \pm 0.2)10^{-3}\ min^{-1}$, were obtained in an analogous fashion. Then $K_{516} = 3.6 \pm 0.25$ and $K_{538} = 3.4 \pm 0.2$. At 623°K the exchange is so fast that the rate cannot be measured accurately, but a conventional method was used and yielded a value of $K_{623} = 2.9 \pm 0.1$. Theoretically, K is given by $f(NH_2T/NH_3)/f(HT/H_2)$, from which the zero-point energy difference $[\Delta E_0(NH_2T)]$ between NH_3 and NH_2T is 919 ± 21 cm^{-1}. From this equation the exchange coefficients were calculated at 516 and 623°C, yielding coefficients of 3.60 and 2.86, respectively. (B.O.G.)

8619 TRANSIENT SPECIES IN THE RADIOLYTIC POLYMERIZATION OF CYANOGEN. C. E. Melton and P. S. Rudolph (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 33: 1592-3(Nov. 1960).

Admixing of noble gases has caused the radiolytic polymerization rates to be increased approximately proportional to the stopping power of the gas. In the $(CN)_2$ + xenon system, charge transfer resulted in an increase rather than a decrease as predicted by the lower ionization potential. Because of this anomaly, the transient species produced in the $(CN)_2$ and $(CN)_2$ + xenon systems were investigated. The reactant gas was irradiated by 135-ev electrons at 1 mm pressure in the ionization chamber of a mass spectrometer. The observed transient polymer species produced in the electron-induced radiolysis of $(CN)_2$, as well as the absolute intensity for each species, are tabulated. When xenon was admixed with $(CN)_2$, the total intensity of the negative ions was markedly increased by ionization by secondary electrons from xenon and a reaction of metastable xenon* ($5p^56s$) with $(CN)_2$ to form CN radicals, which are subsequently ionized. (B.O.G.)

8620 INFRARED ABSORPTION SPECTRUM OF $NdCl_3$. F. Varsanyi and G. H. Dieke (Johns Hopkins Univ., Baltimore, Md.). J. Chem. Phys., 33: 1616-18 (Dec. 1960).

The infrared adsorption spectrum of $NdCl_3$ is obtained under high resolution which shows the transitions from the ground state to $I^4_{13/2}$ and $I^4_{9/2}$, the latter of which was hitherto unknown. The crystals were 5 and 50% $NdCl_3$ in $LaCl_3$, and the higher neodymium concentration shows a decided frequency shift of the lines. (auth)

8621 VAPOR PRESSURES AND RELATED THERMODYNAMIC PROPERTIES OF THE ISOTOPIC NITRIC OXIDE MOLECULES. Jacob Bigeleisen (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 33: 1775–7 (Dec. 1960). (BNL-4817)

The large differences in thermodynamic properties of the isotopic NO molecules are interpreted in terms of the known structure of interacting dimers. It is shown that structural considerations alone suffice to calculate the relative O^{18} to N^{15} isotope effects on vapor pressure, heats of

vaporization, and triple points. The calculated relative quantities are in excellent agreement with experiment. The properties of $N^{15}O^{18}$ are shown to be completely determined by those of $N^{14}O^{16}$, $N^{15}O^{16}$, and $N^{14}O^{18}$. The absolute value of the vapor pressure ratio of $N^{14}O^{16}/N^{15}O^{16}$ is calculated from spectral data in good agreement with experiment. (auth)

8622 RELATION BETWEEN THE PROTON HYPERFINE INTERACTION AND THE $C^{13}-H^1$ SPIN-SPIN COUPLING IN FREE RADICALS. R. A. Bernheim and T. P. Das (Columbia Univ., New York). J. Chem. Phys., 33: 1813-15 (Dec. 1960). (TID-6541)

It is shown that the $C^{13}-H^1$ spin-spin coupling constant $J(C^{13}-H^1)$ and the proton hyperfine constant $Q(H^1)$ in a free radical can be considered as interdependent, and that they both can be estimated by calculating the perturbation produced in the electronic wave functions by the magnetic moment of the proton. For a C−H fragment with an unpaired π electron on the carbon atom, an approximate relation is established between $Q(H^1)$ and $J(C^{13}-H^1)$. Using the experimental value of $J(C^{13}-H^1)$ for the benzene molecule, $Q(H^1)$ is found to have a nagative sign and order of magnitude agreement with experiment. (auth)

8623 INFRARED SPECTRA AND STRUCTURE OF THE ISOMERS OF N_2F_2. Russell H. Sanborn (Lawrence Radiation Lab., Univ. of California, Livermore). J. Chem. Phys., 33: 1855-60 (Dec. 1960).

The isomers of N_2F_2 have been characterized in the past by their reactivity toward mercury. Investigation of the infrared spectra showed that inactive N_2F_2 is trans-1,2-difluorodiazine and may be identified by the single strong band centered at 989 cm^{-1}, with PQR structure. Active N_2F_2 resembles 1,1-difluorodiazine instead of a cis-isomer. This conclusion was reached by considering the mass spectrum, the chemical reactivity, and both the position of the infrared bands and their shapes. 1,1-difluorodiazine may be identified by strong bands at 1524 (PR), 952 (PQR), 896 (PR), and 737 (PQR) cm^{-1}, respectively. Normal coordinate analyses using the Wilson FG-matrix method were performed on both isomers. (auth)

8624 THE SINGLE-STAGE FRACTIONATION FACTOR FOR THE SYSTEM OXYGEN vs. COBALT DI-(SALICYLAL)-ETHYLENEDIIMINE-OXYGEN. L. L. Brown and J. S. Drury (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 33: 1889-90 (Dec. 1960).

The single-stage fractionation factor for O^{16} and O^{18} was measured at room temperature for the system O_2 (gas)−O_2 (sorbed), with the sorption occurring in the solid cobalt di(salicylal) ethylenediimine. The measurements were made in the two following ways: The chelate was recrystallized from pyridine, placed in a long cylindrical tube, and saturated with oxygen gas at 75 cm Hg, or the oxygenated chelate was placed in a spherical reactor, deoxygenated, and pressurized with oxygen gas at 75.7 cm Hg. After equilibration, samples of the gaseous and sorbed phases were collected and analyzed mass spectrometrically. The fractionation factor, $(O^{18}/O^{16})_{gas}/(O^{18}/O^{16})_{solid}$, was determined to be 1.013 ± 0.002 and 1.012 ± 0.002, respectively. It is stated that the isotopic fractionation occurring in this system is due to a quantum mechanical effect. (D.L.C.)

8625 NUCLEAR MAGNETIC RESONANCE STUDY OF THE PROTON TRANSFER IN WATER. S. Meiboom (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 34: 375-88(Feb. 1961).

Measurements of the nuclear relaxation in water are reported. The transverse relaxation rate ($1/T_2$) of the proton resonance is pH dependent. The effect is shown to be due to a spin-spin splitting of the proton resonance by O^{17} (spin $^5/_2$), which is only partially averaged out by proton exchange. The increase of relaxation rate is observable in natural water (0.037% O^{17}) and becomes very appreciable in water enriched in O^{17}. Additional information can be obtained by measuring relaxation rates in the presence of a r-f field H_1, using a method due to Solomon. A study of the width of the O^{17} resonance as a function of pH is in quantitative agreement with the results of the proton resonance. The observations provide a direct determination of the rate constants of the exchange reactions: $H_2O + H_3O^+ \xrightarrow{k_1} H_3O^+ + H_2O$ and $H_2O + HO^- \xrightarrow{k_2} HO^- + H_2O$. It is found that $k_1 = (10.6 \pm 4) \times 10^9$ liter $mole^{-1}$ sec^{-1} and $k_2 = (3.8 \pm 1.5) \times 10^9$ liter $mole^{-1}$ sec^{-1}. The spin-spin interaction between H and O^{17} in water is determined as 92 ± 15 cps. In the appendixes, theoretical equations for the exchange contribution to the relaxation rate are derived. (auth)

8626 VALENCE BOND TREATMENT ON THE B STATE OF THE HYDROGEN MOLECULE. Carmen S. Tschudi and Norah V. Cohan (Universidad Nacional, Buenos Aires). J. Chem. Phys., 34: 401-4(Feb. 1961).

The potential energy of the lowest $^1\Sigma_u^+$ state of the hydrogen molecule is given as a function of the internuclear distance. Calculations were carried out by the valence bond method using Slater 1s and 2p atomic orbitals. Both ionic and covalent structures were considered. The 1s orbitals of the ionic and covalent functions included a variational parameter but the orbital exponent of the 2p orbital was kept constant. It is found that the introduction of the 2p orbital into the wave function results in a considerable improvement of the dissociation energy and that further the state is essentially covalent in character rather than ionic, as previously reported. (auth)

8627 QUASI-LATTICE MODEL OF RECIPROCAL SALT SYSTEMS. A GENERALIZED CALCULATION. Milton Blander (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 34: 432-8(Feb. 1961).

A generalized statistical-mechanical calculation of the solution thermodynamics of the reciprocal molten salt system A^+, B^+, C^-, and D^- dilute in A^+ ions was made. The calculation is based on the quasi-lattice model of reciprocal salt systems and treats the problem as an order-disorder problem. Associations of the A^+ and C^- ions as $A^+ + C^- \rightleftharpoons AC$, $AC + C^- \rightleftharpoons AC_2^-$, and $AC_2^- + C^- \rightleftharpoons AC_3^=$ are taken into account. In terms of the conventional equilibrium constants K_1, K_2, and K_3 for these reactions, respectively, $K_1 = Z(\beta_1 - 1)$, $K_1K_2 = [Z(Z-1)/2!](\beta_1\beta_2 - 2\beta_1 + 1)$, and $K_1K_2K_3 = [Z(Z-1)(Z-2)/3!](\beta_1\beta_2\beta_3 - 3\beta_1\beta_2 + 3\beta_1 - 1)$, where Z is the quasi-lattice coordination number; $\beta_j = \exp(-\Delta A_j/kT)$ and ΔA_j may be termed a specific bond free energy of the jth C^- ion and is the specific Helmholtz free energy change for the formation of the jth bond. The equations demonstrate the surprising fact that the higher order association constants are dependent on the magnitude of the lower order association constants not only through the factor containing Z but also through the values of the β_i for the lower association constants. If $\beta_1 = \beta_2 = \beta_3 = \cdots$ etc., the equations reduce to the statistical ratios of Bjerrum. The higher association constants can be shown to be smaller for a case in which the bonding is directional (e.g., linear AC_2^-), than if they are nondirectional, as in the second and third equation, even if the bond free energies are equal in the two cases. (auth)

8628 KINETICS OF THE REACTIONS OF ALKYL IODIDES WITH HI. Sidney W. Benson and Edward O'Neal

(Univ. of Southern California, Los Angeles). J. Chem. Phys., 34: 514-20(Feb. 1961).

A reexamination of Ogg's data on the kinetics of the reactions of RI + HI → RH + I_2, where R = CH_3, C_2H_5, or n-C_3H_7, shows that the mechanism is a simple I-atom catalyzed, radical reaction with the steps $I + RI \xrightarrow{\frac{1}{2}} R + I_2$ R + HI $\xrightarrow{\frac{1}{3}}$ RH + I. The rate expression is $d(I_2)/dt = k_1k_3K^{1/2}$ (RI)-(HI)/$[k_2(I_2) + k_3$ (HI)], where K is the equilibrium constant for dissociation of I_2. Values are obtained for k_1, and the inhibition ratio k_3/k_2 at one temperature and for k_1k_3/k_2 over a temperature range. Using some entropy estimates, values are deduced for A_1, A_2, A_3, and A_4 (reverse of step 3) all of which seem quite reasonable and self-consistent. The difference ($E_3 - E_2$) appears to lie between 0 and 2 kcal/mole while E_1 is in excess of the estimated endothermicity of reaction (1) by not more than 1.5 kcal/mole. There seems to be good agreement with independent data on the kinetics of pyrolysis of alkyl and aryl iodides which also turn out to be I-atom catalyzed radical reactions. (auth)

8629 REACTION OF CYCLOPROPANE WITH IODINE AND SOME OBSERVATIONS ON THE ISOMERIZATION OF CYCLOPROPANE. Sidney W. Benson (Univ. of Southern California, Los Angeles). J. Chem. Phys., 34: 521-6(Feb. 1961).

The kinetic and thermodynamic data of Ogg and Priest on the system I_2 + cyclopropane ⇌ $ICH_2CH_2CH_2I$ are reexamined. Using an entropy for $ICH_2CH_2CH_2I$, estimated from additivity rules of 93.0 ± 1.5 eu and the experimental value of K^a_{eq}, ΔH^0 is found to be −19.4 ± 0.9 kcal. This gives H^0_f ($ICH_2CH_2CH_2I$) = 8.2 kcal/mole and the use of group additivity rules allow the values of ΔH^0_f for EtI and n-C_3H_7I to be fixed at −3.3 ± 0.5 and −8.3 ± 0.5 kcal/mole, respectively. For CH_3I, ΔH^0_f = 1.6 ± 1 kcal/mole. The kinetic mechanism is also reexamined and from entropy and energy estimates for the free radical species, values of all of the rate constants are evaluated. These are in good agreement with values for similar reactions. It is proposed that the I_2-catalyzed isomerization of cyclopropane proceeds through the step $I + ICH_2CH_2CH_2I \rightarrow HI + ICH_2-CH=CH_2 + I$, followed by a rapid, atom-catalyzed reaction of allyl iodide with HI to give propylene. The rate constants for such a step are also in good agreement with those for similar reactions. Extension of the data to cyclopropane-propylene isomerization is made and it is shown that the most reasonable path involves the trimethylene radical as an intermediate. Its lifetime is, however, very short (~10^{-11} sec). Slater's model for this reaction is shown to be implausible. These data indicate an activation energy for the cyclization of the trimethylene free radical of about 8 kcal. This is reasonable only if the end CH_2 groups in trimethylene are interacting via a "bent" bond. In such case the activation energy arises from the necessity for eclipsed configurations. A similar analysis is made for cyclobutane and the tetramethylene radical with compatible results. For cyclopropane the strain energy is 30 kcal and for cyclobutane 28 kcal. (auth)

8630 INFRARED SPECTRUM AND THERMODYNAMIC PROPERTIES OF RUTHENIUM TETROXIDE. M. H. Ortner (Vitro Corp. of America, West Orange, N. J.). J. Chem. Phys., 34: 556-8(Feb. 1961).

The infrared spectrum of liquid ruthenium tetroxide was determined over the range 300 to 5000 cm^{-1}. Fundamental bands were observed at 330 and 913 cm^{-1}, and were assigned to the infrared active $\nu_3(F_2)$ and $\nu_4(F_2)$ vibrations. A combination band $[\nu_3 + \nu_1](F_2)$ at 1792 cm^{-1} permitted an assignment of the Raman-active $\nu_1(A_1)$ frequency in agreement with earlier work. The final $\nu_2(E)$ Raman-active fundamental was calculated by the OVFF method, and the set of observed and calculated frequencies was utilized to calculate thermodynamic functions for the ideal gas from 298.16 to 1000°K. (auth)

8631 MOLECULAR ASSOCIATION IN ALKALI HALIDE VAPORS. Sheldon Datz, William T. Smith, Jr., and Ellison H. Taylor (Oak Ridge National Lab., Tenn. and Univ. of Tennessee, Knoxville). J. Chem. Phys., 34: 558-64(Feb. 1961).

Molecular association equilibria in alkali halide vapors were studied by measuring the temperature dependence of the molecular weights of gaseous NaCl, NaBr, NaI, KCl, KI, RbCl, and CsCl. The molecular weights were determined by measurement of the absolute pressure exerted by a known weight of completely vaporized salt contained in an isothermal fused silica bulb of known volume. The pressure-sensing element was a fused silica manometer containing molten gold. The apparatus was used in the temperature range of 1175 to 1430°K and pressures of from 10 to 40 mm were measured with a precision of ±0.05 mm. The temperature dependence of the equilibrium constants for the reaction $(MX)_2 \rightleftharpoons 2MX$ yielded dissociation energies (evaluated at 1300°K) ranging from 48.0 kcal/$mole^{-1}$ for NaCl to 34.7 for CsCl. The entropies of dissociation were found to fall within a small range, varying from 28.3 eu for NaCl to 25.0 for KI, and a statistical calculation of the entropy changes based on an ionic model was found to agree well with the experimental values. It is shown that these systems may be adequately described with an electrostatic model, although closer attention should be paid to the nature of polarization interactions. (auth)

8632 TIME SPECTRA OF POSITRONS ANNIHILATING IN ORGANIC LIQUIDS CONTAINING HALOGENS. J. H. Ormrod and B. G. Hogg (Univ. of Manitoba, Canada). J. Chem. Phys., 34: 624-7(Feb. 1961).

Measurements were made of the mean life τ_2 and the per cent I_2 of positrons forming triplet positronium in propyl halides and in benzene-carbon tetrachloride solutions. The experimental variations of I_2 in the propyl halides can be predicted assuming a semiempirical equation of the form $100 - 4/3I_2 = AN_1 + 2.4N_2$, where A is the annihilation factor of the parent molecule and N_1 and N_2 are the per cent volumes of the parent and halide, respectively. A equal to 0.36 is needed for the propyl parent. This equation also predicts correctly the experimental values for the benzyl halides if A equal to 0.53 is used as the benzyl annihilation factor. The quenching of I_2 in the benzene-carbon tetrachloride solutions is much greater than that computed by the equation and the variation in quenching closely resembles that obtained in aqueous nitrate-ion solutions. (auth)

8633 EVALUATION OF ELECTROSTATIC ENERGY LEVELS OF f^6. John B. Gruber and John G. Conway (Univ. of California, Berkeley). J. Chem. Phys., 34: 632-8 (Feb. 1961). (UCRL-9310).

The 119 electrostatic energy levels for an nf^6 configuration were calculated for three different sets of Slater F_k ratios: $4f^6$ hydrogenic − F_4/F_2 = 0.1381, F_6/F_2 = 0.01511; $5f^6$ hydrogenic − F_4/F_2 = 0.1422, F_6/F_2 = 0.0161; and $5f^6$ based on a Hartree-Fock calculation for the normal uranium atom − F_4/F_2 = 0.159, and F_6/F_2 = 0.0204. A tentative theoretical analysis of the absorption spectra of Eu(IV) can be made by using ζ = 1360 cm^{-1} and F_2 = 370 cm^{-1}. The results of our work show clearly that the intermediate field matrices are essential to a quantitative analysis of the Eu(IV) and Am(IV) spectra, and that Zeeman studies are needed to identify certain levels. (auth)

8634 PRESSURE INDUCED COLOR CENTERS IN CaF_2 AND BaF_2. S. Minomura and H. G. Drickamer (Univ. of Illinois, Urbana). J. Chem. Phys., 34: 670-1(Feb. 1961).

The effect of pressure to 52,800 atm was studied on x-irradiated CaF_2 and BaF. The three bands discovered by Smakula are little affected by pressure or bleaching. There are two new bands induced by pressure which are greatly enhanced by any change in pressure. These bands show a marked blue shift with increasing pressure. Each can be bleached by light of its own frequency, and restored by reapplication of pressure. It is suggested that the pressure-induced bands are due to electrons associated with pressure-induced lattice defects, while the bands discovered by Smakula are associated with colloidal deposits or impurities. (auth)

8635 LITHIUM KINETIC ISOTOPE EFFECT IN THE REACTION OF ETHYLLITHIUM WITH BENZYL CHLORIDE. Robert West and William Glaze (Univ. of Wisconsin, Madison). J. Chem. Phys., 34: 685-6(Feb. 1961).

The kinetic lithium isotope effect was studied in the coupling of ethyllithium and benzyl chloride to give n-propylbenzene and LiCl in C_6H_6 as solvent. The reaction was allowed to proceed to half completion using ethyllithium containing approximately equal amounts of Li^6 and Li^7, and the isotope ratio was measured in the LiCl and in the ethyllithium mass spectrometrically. Enrichment of Li^6 in LiCl and Li^7 in the unreacted ethyllithium takes place, the k_6/k_7 value being 1.029 ± 0.008. A calculated value of 1.07 indicates considerable weakening of the C–Li bond upon going to the transition state and implies participation of lithium in the rate determining step. (T.R.H.)

8636 PEROVSKITE-TYPE COMPOUNDS BASED ON PLUTONIUM. L. E. Russell, J. D. L. Harrison, and N. H. Brett (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nuclear Materials, 2: 310-20 (Dec. 1960). (In English). (AERE-R-3044)

The preparation of perovskite type compounds containing trivalent or quadrivalent plutonium was attempted. Crystallographic data for the compounds $PuAlO_3$, $PuVO_3$, $PuCrO_3$, and $BaPuO_3$ are reported. (auth)

8637 HYDROGEN IN ZIRCALOY-2: ITS DISTRIBUTION AND HEAT OF TRANSPORT. A. Sawatzky (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nuclear Materials, 2: 321-8 (Dec. 1960). (In English)

Two determinations of the heat of transport for hydrogen in Zircaloy-2 were made under steady-state conditions over the temperature range 300 to 500°C. Values of 4.7 and 6.1 kcal/mole were obtained. Similar experiments on deuterium gave values of 6.2 and 6.8 kcal/mole. An equation was developed giving the hydrogen concentration in the two-phase (α plus hydride) region as a function of time and temperature. On the basis of this equation, a model for the over-all hydrogen distribution under the influence of a temperature gradient was proposed. The model was fitted to several experimental curves and the agreement was found to be very good. The model predicts that for hydrogen pick-up on the hot surface (as in a failure of a fuel-rod sheath) maximum hydriding will occur at some position displaced from the cold surface. This prediction is supported by observations made on a failed Zircaloy-2-clad UO_2 fuel element. (auth)

8638 HYDROGEN–DEUTERIUM EXCHANGE IN FUSED SILICA. D. L. Fry, P. V. Mohan, and R. W. Lee (General Motors Corp., Warren, Mich.). J. Opt. Soc. Am., 50: 1321-2 (Dec. 1960).

Infrared studies of hydrogen-deuterium exchange in bulk fused silica indicate that the rate of exchange steadily increases with temperature from 600 to 1000°C. The exchange takes place on isolated OH groups and occurs in either direction. (auth)

8639 SOME THERMODYNAMIC PROPERTIES OF THE SYSTEM $PuCl_3$–KCl FROM ELECTROMOTIVE FORCE DATA. R. Benz (Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem., 65: 81-4(Jan. 1961).

The molar free energy of formation of plutonium(III) chloride as a function of temperature (650 to 800°C) and of composition in liquid $PuCl_3$–KCl solutions was determined from emf measurements made on reversible galvanic cells of the type Pu(liq) $|PuCl_3–KCl(liq)|$ $Cl_2(g)$. The free energy of formation of pure supercooled liquid plutonium(III) chloride at one atmosphere can be represented $\Delta F_f^0 = -206 + 0.03858T$ (kcal/mole)(958 to 1014°K.). The standard free energy of formation of solid plutonium(III) chloride can be represented $\Delta F_f^0 = -221 + 0.05328T$ (kcal/mole)(958 to 1014°K.). (auth)

8640 ELECTRICAL CONDUCTIVITY OF SOME ORGANIC SOLUTES IN ANHYDROUS HYDROGEN FLUORIDE. Lloyd Quarterman, Herbert H. Hyman, and Joseph J. Katz (Argonne National Lab., Ill.). J. Phys. Chem., 65: 90-3 (Jan. 1961).

Many organic liquids containing oxygen are miscible with anhydrous hydrogen fluoride. Ethanol, acetic acid, and diethyl ether are typical proton acceptors and form highly conducting solutions over most of the concentration range. Trifluoroethanol, trifluoroacetic acid, and nitrobenzene are much less extensively ionized in this medium. Perfluorobutyl ether is essentially insoluble. The electrical conductivities for these systems are tabulated and compared. (auth)

8641 THE REACTIVITY OF HYDROGEN ATOMS IN THE LIQUID PHASE. Thomas J. Hardwick (Gulf Research and Development Co., Pittsburgh). J. Phys. Chem., 65: 101-8(Jan. 1961).

A method is described in which hydrogen atoms, produced in situ by the radiolysis of a saturated hydrocarbon as solvent, are allowed to react competitively with a reactive solute and the solvent. A kinetic expression is derived whereby the relative rate constants for the competing reactions can be calculated from a measurement of the hydrogen gas yield as a function of solute concentration. From previous measurements of the absolute rate constants of H + solute, absolute rate constants for the reaction H + paraffin solvent are obtained. These rate constants show an effect of the molecular structure of the paraffin solvent. Specific values can be assigned to primary, secondary, and tertiary groups, from which the absolute rate constant of the reaction of hydrogen atoms with any saturated liquid hydrocarbon may be calculated. If rate constants so measured or calculated are compared with the corresponding published values of H + paraffin in the gas phase, reasonable agreement is found. It is thus concluded that such radical-molecule reactions occur at the same rate in the gas phase as in hydrocarbon solvent. (auth)

8642 THE HYDROGEN FLUORIDE–ANTIMONY PENTAFLUORIDE SYSTEM. Herbert H. Hyman, Lloyd A. Quarterman, Martin Kilpatrick, and Joseph J. Katz (Argonne National Lab., Ill.). J. Phys. Chem., 65: 123-7(Jan. 1961).

Antimony pentafluoride and hydrogen fluoride as liquids are miscible in all proportions. Observations on the reactivity of mixtures were interpreted in terms of fluoride ion acceptor behavior to form an octahedrally symmetrical SbF_6^-. Platinum, polychlorotrifluorethylene, sapphire, and

silver chloride can be used in constructing optical equipment for this system. Suitable cells were devised and the electrical conductivity, and the infrared and Raman spectra were observed throughout the concentration range. Spectral patterns were identified for pure SbF_5, pure HF, a highly symmetrical species, presumably SbF_6^-, and a more complex species, possibly the ion pair $H_2F^+SbF_6^-$. The observations can be described by a set of equations $2HF + SbF_5 \overset{(1)}{\rightleftharpoons} H_2F^+SbF_6^- \overset{(2)}{\rightleftharpoons} H_2F^+ + SbF_6^-$. At 20 mole % SbF_5, $K_1 \cong 4.4 \times 10^{-4}$ and $K_2 \cong 1.7 \times 10^2$. At lower SbF_5 concentrations, the ionic dissociation becomes essentially complete. The electrical conductivity is at a maximum near 10 mole % SbF_5. At higher concentrations, the amount of ionization drops off rapidly and the complex becomes the predominant species. (auth)

8643 MEASUREMENT OF DONNAN RATIO BY RADIOACTIVE TRACERS AND ITS APPLICATION TO PROTEIN-ION BINDING. Abraham Saifer and Joseph Steigman (Polytechnic Inst., Brooklyn). J. Phys. Chem., 65: 141-4(Jan. 1961).

Binding of iodide ion from solutions of sodium or potassium iodide to deionized bovine serum albumin (BSA) and to bovine serum mercaptalbumin (BSM) was studied by equilibrium dialysis using radioactive I^{131} as a tracer. The Donnan effect was evaluated by introducing another radioactive ion, e.g., Na^{24}, into the system which does not bind to these proteins. In acid solutions of BSA unbound hydrogen ions measured by pH showed the same distribution across the membrane as did the Na^{24} ions. In addition, at pH 12, where iodide ion should not bind, the I^{131} ratio across the membrane was equal to the reciprocal of the Na^{24} ratio. Finally at isoionic pH, the binding constants for iodide ion to BSM determined by this method were shown to be in close agreement with those obtained by other workers by means of e.m.f. measurements. (auth)

8644 THERMODYNAMICS OF THERMOCELLS WITH FUSED OR SOLID ELECTROLYTES. Kenneth S. Pitzer (Univ. of California, Berkeley). J. Phys. Chem., 65: 147-50(Jan. 1961).

The thermodynamic principles related to thermocells are reviewed. The equation for the potential of a cell with a single component electrolyte, such as a fused or solid salt, is similar to that for a cell with aqueous solution electrolyte after the Soret equilibrium has been established. In particular the total "transported entropy" of the ionic species reacting at the electrodes may be obtained without any complication from transference numbers, and values of this quantity are given for several cells. The meaning and measurability of the partial molal entropies of single ions in electrolytes are considered. It is found that the transported entropy of metal ions in fused salts is approximately equal to estimated values of the partial molal entropies of these ions; hence the entropies of transfer are small. In solid electrolytes the entropies of transfer are sometimes large and are discussed in terms of the probable conductance mechanisms. (auth)

8645 THE HEAT OF CHLORINATION OF DIBORON TETRAFLUORIDE. Stuart R. Gunn and LeRoy G. Green (Univ. of California, Livermore). J. Phys. Chem., 65: 178-9(Jan. 1961).

B_2F_4 samples were chlorinated in a calorimeter, and the heat of chlorination was determined to be -82.0 ± 1.0 kcal/mole. From previous work, $\Delta H_f^0(B_2F_4)$ is calculated to be -342.0 kcal/mole and E(B-B) for B_2F_4 to be 72.4 kcal/mole. (D.L.C.)

8646 THE FORCES BETWEEN POLYATOMIC MOLECULES. I. LONG-RANGE FORCES. H. C. Longuet-Higgins and L. Salem (University Chemical Lab., Cambridge, Eng.). Proc. Roy. Soc. (London) A, 259: 433-41 (Jan. 24, 1961).

It is known that the electrostatic long-range forces between two molecules are locally additive in the sense that the first-order interaction energy between molecules bearing charges or permanent multipole moments may be written as a double integral over pairs of points, one in each molecule. The second-order interaction energy is examined which comprises polarization and dispersion terms. The corresponding forces are locally additive or not according as the electron correlation within each molecule does or does not die away rapidly with distance. (auth)

8647 THE PINACOL REARRANGEMENT. Clair J. Collins (Oak Ridge National Lab., Tenn.). Quart. Revs. (London), 14: 357-77(1960).

Progress in understanding the mechanism of the pinacol rearrangement is reviewed. (T.R.H.)

8648 REACTION BETWEEN CERIUM(III) AND COBALT(III). PART 3. THE EFFECT OF SULPHATE AND BISULPHATE IONS. L. H. Sutcliffe and J. R. Weber (Univ., Liverpool). Trans. Faraday Soc., 57: 91-8(Jan. 1961).

By means of spectrophotometric method, cobaltic ions in perchloric acid are shown to associate with at least one sulfate ion. These complexes were found to be reactive entities in the oxidation of cerous by cobaltic ions in sulfate media. Raising the temperature from 20 to 30°C converts the predominantly reactive Co(III) sulfate species from $CoSO_4^+$ to $Co(SO_4)_2^-$. The ion-pair $CoSO_4^+$ seems to be intermediate in reactivity toward Ce(III) when compared with CoF^{2+} and $CoNO_3^{2+}$. (auth)

8649 NEGATIVE ISOTOPE EFFECT IN THE VISCOSITY OF DEUTEROCOMPOUNDS. I. B. Rabinovich, A. A. Lobashov, and V. I. Kucheryavyi (Gor'kii State Univ., U.S.S.R.). Zhur. Fiz. Khim., 34: 2202-4(Oct. 1960). (In Russian)

It was shown for the first time using chloroform and tetrabromoethane that substitution of hydrogen by deuterium may cause a fall in viscosity. This phenomenon alongside data on the increase in viscosity during the same isotopic substitution was explained by the superposition of two factors affecting the viscosity in opposite directions, namely, increase in molecular weight and decrease in Van der Waals interaction. (auth)

8650 ISOTOPIC EFFECT IN THE THERMODYNAMIC PROPERTIES OF LIQUID MIXTURES. I. THE ISOTOPIC SHIFT IN THE VAPOR PRESSURE–COMPOSITION DIAGRAM OF MIXTURES OF DEUTEROCHLOROFORM WITH ACETONE. I. B. Rabinovich and P. N. Nikolaev (Lobachevskii Gor'kii State Univ., U.S.S.R.). Zhur. Fiz. Khim., 34: 2289-98(Oct. 1960). (In Russian)

The effect of the substitution of hydrogen by deuterium in chloroform on the vapor pressure of its mixtures with acetone was studied for concentrations 0 to 100% chloroform and temperatures of 25, 35, and 50°C. From the experimental data the isotopic effect in the activities and activity coefficients of the components, in the change in chemical potentials and the isobaric potential of mixing, in the excess values of these quantities, and in the heats of vaporization and mixing was calculated. The isotopic shift caused an increase in the vapor pressure of pure chloroform but a fall in the vapor pressure of its mixtures with acetone, provided the concentration of the latter was no less than 15 molar %. The association energy in the range of 40 to 65 molar % of chloroform in the system deuterochloroform—acetone was several tens of cal/mole higher than in the system chloroform—acetone. The isotopic effects re-

vealed in the properties of the solutions were explained by an increase in the degree of association by means of the deuterium bond as compared to the hydrogen bond, owing to the greater strength of the former. (auth)

8651 MEASUREMENT OF THE RADIOACTIVITY OF TRITIUM- OR CARBON^{14}-LABELLED GASOLINE AND BENZENE VAPORS. E. E. Finkel (Scientific-Research Inst. of Cable Industry, Moscow, U.S.S.R.). Zhur. Fiz. Khim., 34: 2365-6(Oct. 1960). (In Russian)

It was shown that Geiger counters have good characteristics on being filled with gasoline or benzene vapors to a pressure of 5 to 25 mm Hg, if the length of the plateau is no less than 200 V for a slope less than 5% per 100 V. The radioactivity of the H^3- or C^{14}-labeled vapors of the compounds can be measured by using them as one-component gaseous fillers of the counter. (auth)

8652 DETERMINATION OF THE COEFFICIENTS OF CONDENSATION OF LITHIUM, BERYLLIUM, BORON, SILICON AND LEAD OXIDES. L. P. Firsova and An. N. Nesmeyanov. Zhur. Fiz. Khim., 34: 2719-22(Dec. 1960). (In Russian)

The cofficients of the condensation of lithium, beryllium, boron, silicon, and lead oxides were evaluated by comparison of the experimental data on the vapor pressures of the compounds obtained by the Langmuir and Knudsen methods. The values for the condensation of the oxides are close to unity. (auth)

8653 ON THE REACTION OF TRIVALENT THALLIUM WITH DISODIUM SALT OF ETHYLENE-DIAMINE-TETRAACETIC ACID. A. I. Busev, V. G. Tiptsova, and T. A. Sokolova (Lomonosov, Moscow State Univ., U.S.S.R.). Zhur. Neorg. Khim., 5: 2749-58(Dec. 1960). (In Russian)

The composition and stability of trivalent thallium complexes with ethylenediaminetetraacetic acid were studied in relation to pH. The first and second dissociation constants $K_1 = 0.5 \times 10^{-2}$ and $K_2 = 1.6 \times 10^{-8}$ were determined by a potentiometric method at 20°C and ionic force 0.1. The instability constants of the trivalent thallium complex (at 20°C and ionic force 0.4) is $K_{TlY} = 3.3\ (\pm 3.5) \times 10^{-22}$. The pK_{inst} at 20°C and ionic force 0.1 is 22.5 ± 0.5. Theoretical calculations based on the above data are given for the optimum pH in complexometric titration of trivalent thallium. (R.V.J.)

8654 COMPLEX FORMATION OF RARE-EARTH IODIDES–IODINE IN AQUEOUS SOLUTIONS. L. A. Alekseenko, G. G. Saprina, and V. V. Serebrennikov. Zhur. Neorg. Khim., 5: 2824-6(Dec. 1960). (In Russian)

Experimental studies of solubility, optical density, and distribution coefficients show polyiodides formed in aqueous solutions containing La, Ce, Pr, Nd, and Sm iodides and iodine. A reduced strength in the series La–Nd–Sm polyiodides results from an increased counter polarizing action of the rare-earth ions due to their reduced radii. (R.V.J.)

8655 SPECTROPHOTOMETRIC STUDIES OF PLUTONIUM(IV) COMPLEXING WITH NITRIC ACID SOLUTIONS. L. V. Lipis, B. G. Pozharskiĭ, and V. V. Fomin. Zhur. Strukt. Khim., 1: 135-44(July-Aug. 1960). (In Russian)

Plutonium(IV) complexing in nitric acid solutions was studied. Increased concentrations of anions and cations possessing considerable hydration energy contribute to the formation of complexes with large nitrate contents. The composition of complex ions is described by the formula $[Pu(NO_3)_n\ (H_2O)_{8-n}]^{4-n}$, where $n = 1$ to 6. (tr-auth)

8656 PROTON RELAXATION IN DIAMAGNETIC SALT AQUEOUS SOLUTIONS. III. EFFECTS OF PARAMAGNETIC POLARIZATION. V. M. Vdovenko and V. A. Shcherbakov (Khlopin Radium Inst., Academy of Sciences, U.S.S.R., Leningrad). Zhur. Strukt, Khim., 1: 268-9(July-Aug. 1960). (In Russian)

Nuclear relaxation was studied with a specimen of UO_2^{2+}. The proton relaxation time variations in uranyl nitrate solutions are plotted. It is shown that polarized paramagnetism reduces the proton relaxation time in relation to the effective magnetic moment μ_N. The efficiency of the ion in relation to $1/T_1$ is determined by a μ_N moment equal to $(1.0 \text{ to } 1.4) \times 10^{-2}$ Bohr magnetons. The hydrolysis of paramagnetically polarized ions covalently reacting with water increases due to additional perturbation in the ground state. The magnitude of the effective magnetic moment for uranyl ions in nitrate solutions was $(7.2 \pm 0.9) \times 10^{-2}$ Bohr magnetons. (R.V.J.)

8657 TERNARY LAMELLAR COMPOUNDS OF LITHIUM OR SODIUM WITH GRAPHITE. Marceline L. Dzurus, Gerhart R. Hennig, and George L. Montet (Argonne National Lab., Ill.). p.165-8 of "Proceedings of the Fourth Conference on Carbon." New York, Pergamon Press, 1960.

Lamellar compounds of graphite are formed by the heavy alkali metals potassium, rubidium, and cesium. Some doubt exists as to whether lithium and sodium can also form such compounds with graphite. Considerations of the energy of formation indicate that neither of these two substances should form concentrated lamellar compounds with graphite. It was found that very pure sodium does not appear to react with graphite at temperatures up to 450°C. However, reactions can be promoted by small amounts of impurities such as sodium hydroxide, sodium oxide, barium oxide, and ammonia. It is believed that the impurities occupy so-called "spacer" positions in the lattice and thus facilitate the intercalation of sodium. However, it seems likely that very low concentrations of impurity act as catalysts. Experiments with lithium seem to indicate that it will also react with graphite only when impurities are present. (auth)

8658 RARE-EARTH ELEMENTS. (EXTRACTION, ANALYSIS, APPLICATIONS). (Redkozemel'nye Elementy (Poluchenie, Analiz, Primenenie)). D. I. Ryabchikov, ed. 363p. Translation of a Publication of Academy of Sciences, USSR, Moscow, 1959. $3.75(OTS). (OTS-60-21172; PST Cat. No. 116)

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract no. 19942.

8659 GAS TREATMENT. (to Engelhard Industries, Inc.). French Patent 1,214,015. Nov. 2, 1959.

A method is given for catalytically recombing H_2 and O_2 in the presence of H_2O vapor, utilizing Ni, Pd, or Pt/Rh on a SiO_2/Al_2O_3 support as a catalyst. The metal constitutes 0.1 to 5 wt.% of the catalyst, and the support contains at least 4% SiO_2. The temperature of the metal is 100 to 800°C and the H_2 and O_2 concentration in the gas is kept beneath the explosion limit. (NPO)

Analytical Procedures

8660 (ARL-TR-60-318) VACUUM ULTRAVIOLET SPECTROGRAPHIC INVESTIGATION OF GASEOUS IMPURITIES IN METALS. Boris Vodar (France. Centre National de la Recherche Scientifique. Laboratoire des Hautes Pressions, Bellevue). Oct. 1960. 30p. Contract AF61(052)-77.

The possibilities of vacuum ultraviolet spectroscopy for determining gases in titanium were studied. Measurements were made on sensitive lines emitted by ions having only

one or two electrons on the outer shell. The ions were produced by vacuum sparks and their sensitive lines were located in the far ultraviolet region. They were observed with a vacuum normal incidence concave grating spectrograph which may be provided with photographic or photoelectric receiving equipment. Several tests showed that the vacuum sliding spark is not a convenient source. The vacuum triggered spark (without support) gave interesting results for oxygen and nitrogen, and seems to be convenient for this purpose. Attempts were made to improve the performances. Results of some measurements are reported. Hydrogen is a particular case and the tests made indicated that a source of high excitation energy is unsuitable. (auth)

8661 (BM-RI-5687) VOLUMETRIC DETERMINATION OF URANIUM IN THE PRESENCE OF HIGH CONCENTRATIONS OF IRON. Thomas J. Blalock (Bureau of Mines, Washington, D. C.). Nov. 1959. 11p.

Results are given of an investigation conducted to develop a more accurate procedure for determining small amounts of uranium in the presence of large amounts of iron in materials such as shale or black sands. Results indicated that by use of double precipitation of uranium tetrafluoride from reduced acid solutions, concentrations as low as 0.1 to 0.2 mg of uranium per 100 ml solution could be quantitatively separated, provided a suitable carrier is present and ammonium chloride is added to prevent peptization. Uranium was determined by titration with ceric sulfate. (J.R.D.)

8662 (CF-59-4-106) SPECTROPHOTOMETRIC DETERMINATION OF COPPER IN YTTRIUM METAL WITH NEOCUPROINE. J. C. White (Oak Ridge National Lab., Tenn.). Apr. 21, 1959. 9p.

The neocuproine colorimetric method was applied to the determination of copper in yttrium metal. From 5 to 80 μg of copper was determined in the presence of as much as 500 mg of yttrium with a coefficient of variation of 2%. Copper was reduced to copper (I) with hydroxylamine and complexed with neocuproine (2,9-dimethyl-1,10-phenanthroline). The colored complex was extracted into chloroform and its absorbance measured, after dilution with ethanol, at 457 mμ. (auth)

8663 (CF-59-5-72) HIGH-FREQUENCY TITRATION AS APPLIED TO THE DETERMINATION OF THORIUM, URANIUM, SULFATE, AND FREE ACID. PARTS I–V. Oscar Menis (Oak Ridge National Lab., Tenn.). May 11, 1959. 20p.

The technique of high-frequency titrimetry was applied to the determination of thorium, uranium, sulfate, and free acid. In Part I, the reproducibility of the method for the titration of standard solutions that contained 50 mg of thorium in the absence of interferences is established. Under these conditions, the coefficient of variation of the method was <1%. In Part II, the effect of uranium on the high-frequency titration of thorium, as well as the application of the method to actual samples, is discussed. Uranium in a ratio of 5 to 1 to thorium can be tolerated. When the method is applied to the analysis of representative samples, the coefficient of variation is 1%. Attempts to determine uranium by high-frequency titration with 8-quinolinol were unsuccessful. Tests on this titration and possible reasons for its failure are discussed in Part III. The application of the high-frequency titration method to the determination of sulfate in solutions of uranyl sulfate is described in Part IV. The coefficient of variation, on titrating 40 to 70 mg of sulfate with barium chloride after the uranium is masked with citrate or fluoride, is 2%. In Part V, the high-frequency titration of free acid in solutions of uranyl sulfate is discussed. Uranium up to 350 mg, which was the highest level tested, does not interfere. The coefficient of variation of the method is ~2%. (auth)

8664 (CF-59-8-144) AN ATTEMPT TO DUPLICATE A DIRECT SPECTROPHOTOMETRIC METHOD FOR THORIUM PROPOSED BY GURUPADA BANERJEE. H. L. Holsopple, Jr. (Oak Ridge National Lab., Tenn.). Aug. 13, 1959. 8p.

An attempt was made to apply a method developed by G. Banerjee to the colorimetric determination of thorium. In this method, 2-p-sulfophenylazo-1, 8-dihydroxynaphthalene-3,6-disulfonic acid is used as the chromogenic reagent. Thus far, Banerjee's results have not been reproduced. (auth)

8665 (CF-59-9-38) APPLICATION OF XYLENOL ORANGE INDICATOR IN THE COMPLEXOMETRIC TITRATION OF THORIUM. Oscar Menis (Oak Ridge National Lab., Tenn.). Sept. 9, 1959. 11p.

A method for the determination of thorium in slurries by direct titration with ethylenediaminetetraacetic acid, using xylenol orange as the indicator, is described. The effect of using various amounts of an acetate or a glycine buffer was investigated, as well as the effect of interfering ions. This method, based on the use of xylenol orange as the indicator and glycine as the buffer, proved to be satisfactory. (auth)

8666 (CF-59-12-32) DETERMINATION OF FREE ACID IN URANYL SULFATE SOLUTIONS BY CONDUCTOMETRIC TITRATION. Gerald Goldstein (Oak Ridge National Lab., Tenn.). Dec. 4, 1959. 5p.

A conductometric method for the estimation of free acid in solutions containing hydrolyzable ions was adapted to the determination of sulfuric acid in uranyl sulfate solutions. Sodium fluoride was added in approximately the stoichiometric amount required to convert UO_2^{++} and any other hydrolyzable ions to slightly ionized fluorides, and large platinum-plate electrodes were utilized. For samples containing 0.02 meq of sulfuric acid, the coefficient of variation was found to be 1% or less. (auth)

8667 (CF-60-12-43) ANALYSIS OF URANIUM FUEL-ELEMENT WAFERS FROM ATOMICS INTERNATIONAL FOR URANIUM, PLUTONIUM, AND SAMARIUM. M. J. Gaitanis (Oak Ridge National Lab., Tenn.). Dec. 27, 1960. 25p.

Irradiated and unirradiated SRE fuel-element wafers were analyzed. Each wafer was analyzed for samarium by emission spectrography. The unirradiated wafers were analyzed for uranium by coulometric and potentiometric methods and for uranium isotopes by mass spectrometry. The irradiated wafers were analyzed for uranium and plutonium by coulometric methods, for plutonium by the thenoyltrifluoroacetone radiochemical method, for plutonium isotopes by the 256-channel α-pulse analyzer, and for the isotopes of uranium and plutonium by mass spectrometry. The methods of preparing wafers for analysis are discussed; the data are tabulated. (auth)

8668 (GEAP-3273) COLLECTED METHODS FOR ANALYSIS OF SODIUM METAL. H. E. Perrine (General Electric Co. Atomic Power Equipment Dept., Pleasanton, Calif.). Oct. 15, 1959. 24p. For Atomics International. Div. of North American Aviation, Inc. Subcontract N8-S-452.

Methods for analyzing chemical impurities in sodium metal samples are presented. Chemical analysis was used to determine impurities in calcium, carbon, chromium, iron, lithium, nickel, oxygen, potassium, and zirconium.

Spectrographic analysis was used to determine other impurities. Sodium samples obtained from experimental apparatus were analyzed by these methods. (auth)

8669 (HW-58184) LITERATURE REVIEW ON BORON ANALYSIS. R. W. Stromatt (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 24, 1958. 4p. Contract AT(45-1)-1350.

Analytical methods are reviewed for the determination of boron (as B^{10}) in the dissolver feed solutions and in the dissolver solutions after dissolution. Volumetric, colorimetric, spectrographic, flame photometric, polarographic, polarimetric, and neutron-absorption procedures are discussed. 21 references. (auth)

8670 (IGO-AM/S-151(2nd. ed.)) THE DETERMINATION OF COMBINED CARBON IN BERYLLIUM METAL (BY IGNITION WITH A GASOMETRIC FINISH). (United Kingdom Atomic Energy Authority. Industrial Group. Springfields Works, Springfields, Lancs, England). Mar. 3, 1959. 11p.

The beryllium sample is dissolved in H_2SO_4, and the evolved gases (methane and hydrogen) are passed over copper oxide at 850°C. The water produced is removed, and the carbon dioxide is measured by a gasometric finish. The lower limit of carbon detection is ~30 ppm. (auth)

8671 (K-995) AN IMPROVED THERMAL CONDUCTIVITY GAS ANALYZER FOR HELIUM–CARBON DIOXIDE MIXTURES. H. S. McKown (Carbide and Carbon Chemicals Co. K-25 Plant, Oak Ridge, Tenn.). Apr. 6, 1953. Decl. Mar. 7, 1960. 23p.

An improved thermal-conductivity gas analyzer for He-CO_2 mixtures is described, including gas sampling systems and circuit diagrams. Three gas streams are continuously monitored with a concentration range of 18 to 70% with a precision of ±0.05%. (auth)

8672 (NBL-165) SEMI-ANNUAL PROGRESS REPORT FOR THE PERIOD JANUARY 1960 THROUGH JUNE 1960. C. J. Rodden (New Brunswick Lab., AEC, N. J.). Jan. 1961. 68p.

Modifications were made in the Carlson and Banks procedure for the spectrophotometric determination of silicon in beryllium metal and oxide. The refractory oxide is dissolved directly in hydrofluoric acid. The identical procedure is used for metal after ignition to the oxide. Concentrations of beryllium over certain limits have a quenching effect on the fluorescence of the aluminum-Pontachrome Blue Black R complex. The determination of trace amounts of aluminum in beryllium can be carried out despite this quenching effect by the method of standard addition. Samples of plutonium sulfate tetrahydrate prepared 9 to 12 months earlier were under investigation to determine the suitability of this compound as a primary analytical standard of plutonium. The compound was determined experimentally to contain four molecules of water of crystallization. Plutonium sulfate tetrahydrate was found to lose a major portion of its water of crystallization when heated at 115°C. Indications, but no conclusive evidence, of the existence of another intermediate hydrate of plutonium(IV) sulfate, were found. Microscopic examination of 1-year-old crystals of $Pu(SO_4)_2.4H_2O$ shows no evidence of the effect of any α radiolysis on the water of crystallization. Continued exposure to a fluctuating atmosphere caused no apparent changes in crystal structure or weight. Heating $Pu(SO_4)_2.4H_2O$ to 325°C produced a dehydrated salt of weight equivalent to the formula, $Pu(SO_4)_2$. This material, although slightly hygroscopic, can be readily dried at 120°C and appears to be satisfactory for further investigation of its suitability as an alternate primary standard of plutonium. A method is presented for the rapid determination of milligram quantities of sulfate in pure plutonium sulfates. Plutonium is adsorbed on a cation resin and an acidimetric titration is made of the displaced hydrogen ion which is equivalent to the sulfate content of the sample. A technique used for the prevention of plutonium hydrolysis in neutral solution is described. The method may be applied to the determination of sulfate in any pure plutonium sulfate. A method is described for sampling and analyzing uranium in graphite waste. Sampling data indicate that representative sampling is obtained if the material is pulverized to less than 30-mesh size before reducing to 20 to 50-g portions for analysis. A HNO_3 (1 + 3) digestion is sufficient for extracting the total uranium in the waste material. Details for the preparation of synthetic scrap solutions of uranium-aluminum, uranium-stainless steel, and uranium-Zircaloy-2 are presented. Methods of analysis are described and precision data given for the determination of uranium in these solutions. Further evaluation of the isotopic abundance of uranium by mass spectrometric determination was made, and comparisons are shown for National Bureau of Standards and New Brunswick Laboratory values of standard sample NBS-U-200. (auth)

8673 (PG-Report-156) ANALYTICAL METHODS FOR THE DETERMINATION OF CAESIUM-137, STRONTIUM-89 AND -90 IN MILK, VEGETATION, ORGANIC ION EXCHANGE RESINS, SEAWEED AND FISH FLESH, AND STRONTIUM-89 AND -90 IN BONE. (United Kingdom Atomic Energy Authority. Production Group. Windscale, Sellafield, England). 1960. 22p.

The method is suitable for the determination of Cs^{137}, Sr^{89}, and Sr^{90} in the same sample portion and is therefore particularly useful when the sample size is limited or when the concentrations of the isotopes are very low. Detection limits are governed by natural background radiation which is dependent upon local conditions. The method was applied to samples containing 2 to 1500 $\mu\mu$c Cs^{137}; 20 to 5000 $\mu\mu$c Sr^{89}, and 1 to 1000 $\mu\mu$C Sr^{90} per sample portion. The samples are ignited and the residues are leached with or dissolved in hydrochloric acid. Strontium and cesium carriers are added to the solutions and the cesium then separated as the silicotungstate, which is dissolved in sodium hydroxide. After further purification on anion and cation exchangers, the cesium is precipitated as the perchlorate, which is counted for β activity. The strontium is precipitated as nitrate from the supernate of the silicotungstate precipitation and then as the carbonate. After further precipitations as the nitrate and carbonate together with a barium chromate and a ferric hydroxide scavenge, the strontium is finally separated as the carbonate, which is counted for Sr^{89} activity. After allowing the Y^{90} to grow into near equilibrium the yttrium with added carrier is separated first as the hydroxide and finally as the oxalate, which is counted to measure the Sr^{90} content. The β-counting equipment is calibrated against standard Sr^{89}, Y^{90}, and Cs^{137} sources, and the results are corrected for chemical yield and where necessary for radioactive decay. Only Sr^{89} and Sr^{90} are determined in samples of bone. (auth)

8674 (PG-Report-161) ANALYTICAL METHOD FOR THE RADIOCHEMICAL DETERMINATION OF TECHNETIUM-99 IN NITRATE SOLUTIONS BY SOLVENT EXTRACTION OF TETRAPHENYLARSONIUM PERTECHNETATE. (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). 1960. 12p.

Tc^{99} is separated from inorganic ions (particularly nitrate) by hydrogen sulfide, using platinum as carrier. The mixed sulfides are dissolved in ammoniacal hydro-

gen peroxide. Ammonium carbonate and tetraphenylarsonium chloride are added, and the technetium is extracted into chloroform. The β activity of the extract is determined by counting, and any radioruthenium present is determined and corrected for by another β count with added absorber. (auth)

8675 (TID-11044) PROGRESS REPORT ON [SPECTROCHEMICAL ANALYSIS]. Technical Report No. 13. (Anderson Physical Lab., Champaign, Ill.). October, 1960. 18p. Contract AT(11-1)-544.

A vacuum fusion procedure was developed for spectrochemical determination of H_2, O_2, CO, CO_2, SO_2, Cl, and H_2O in salts. The preparation of standards is described, and their use in calibration of the cathode layer technique is detailed. (W.D.M.)

8676 (TID-11544) ENTHALPY TITRATIONS IN FUSED SALTS (SUPPLEMENTED BY POLAROGRAPHY AND AMPEROMETRIC TITRATIONS). Annual Progress Report for Period Covered January 1, 1960–December 31, 1960. Joseph Jordan (Pennsylvania State Univ., University Park). Jan. 13, 1961. 40p. Contract AT(30-1)-2133.

Seventy thermodynamic parameters were determined under virtually isothermal conditions (±0.5°C) at specified temperatures between 400 and 650°K. For describing the "liquid structure" of fused alkali nitrate solvents, a "hole-model" was developed which accounts for remarkable entropy effects observed experimentally. Methodological advances included: the construction of a "titration calorimeter" suitable for studies of oxidation-reduction reactions in chloride melts at temperatures up to 1300°K and the application of tracer contact-autoradiography to the identification of "active sites" on electrode surfaces. (auth)

8677 (Y-1329) THE DETERMINATION OF THORIUM AND URANIUM AS TRACE IMPURITIES IN BERYLLIUM METAL. W. C. Dietrich (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Dec. 14, 1960. 19p. Contract W-7405-eng-26.

A method for the determination of microgram quantities of thorium and uranium in beryllium metal was developed. Both thorium and uranium are separated from beryllium in a nitrate system by a tri-n-octylphosphine oxide extraction. Thorium is subsequently re-extracted from the organic phase into 0.3M sulfuric acid and is determined colorimetrically by thoron. Uranium remains in the organic phase and is determined directly by a fluorophotometric method. (auth)

8678 (AEC-tr-4136) ISOTOPIC WATER ANALYSIS. A. I. Shatenshtein, E. A. Yakovleva, E. N. Zvyaginsteva, Ya. M. Varshavskiĭ, E. A. Izrailevich, and N. M. Dykhno. Translated from a publication of the Academy of Science of the U.S.S.R., Moscow, 1957. (Translated by the L & S Technical Literature Service, Columbus, Ohio). October 1960. 304p. Contract AT(40-1)-2471.

Procedures are described for the isotopic analysis of water. Data are presented on the isotopic composition of natural water; the purification of water for isotopic analysis; determination of the concentration of heavy isotopes of hydrogen and oxygen by density measurements; the pycnometric method of measuring density; the drop method for determining density; the flotation method for measuring density; the determination of deuterium concentration by the index of refraction; the determination of the isotopic composition of oxygen in heavy water; preparatory work for analysis; methods of water purification for isotopic analysis; methods for precision temperature control; the separate determination of the concentration of deuterium and the heavy isotopes of oxygen in water by isotopic exchange; determination of concentration of heavy oxygen isotopes in water by the iron-vapor method, interferometric measurement of the difference of the refractive indexes; and tables for use in finding the deuterium concentration in water. Densimetric and interferometric methods of isotopic analysis are described and discussed in detail. 259 references. (C.H.)

8679 (AEC-tr-4433(Pt. I)) SPECTRAL METHOD OF DETERMINING THE ISOTOPIC COMPOSITION OF LEAD. PART 1. A. N. Zajdel, A. G. Zhiglinskii, and J. Cajko. Translated by Lydia Venters (Argonne National Lab.) from Czechoslov. J. Phys., 8: 530(1958). 18p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 6265.

8680 (AEC-tr-4433(Pt. II)) SPECTRAL METHOD OF DETERMINING THE ISOTOPIC COMPOSITION OF LEAD. PART 2. A. N. Zajdel, A. G. Zhiglinskii, and J. Cajko. Translated by Lydia Venters (Argonne National Lab.) from Czechoslov. J. Phys., 8: 665(1958). 26p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 5212.

8681 (JPRS-4320) HYDROLYSIS AND ANALYTICAL CONTROL OF NITRIC ACID ESTERS ("NITRO-BODIES"). E. Schulek, K. Burger, and M. Feher. Translated from Z. anal. Chem., 177: No. 2, 81-6(1960). 7p.

Determinations of ammonia, cyanide, nitrite, and nitrate contents in glycerol trinitrate, pentaerythrital tetranitrate, nitrostarch, and nitrocellulose are described. In addition, the alternating ratios of nitrate and nitrite nitrogen in these hydrolysates were calculated. The mean values of these ratios were 1 to 0.83 for pentaerythritol tetranitrate, 1 to 2.14 for glycerol trinitrate and nitrostarch, and 1 to 1.46 for nitrocellulose. (J.R.D.)

8682 (UCRL-Trans-635(L)) INDIRECT COULOMETRIC TITRATION OF REDUCIBLE ORGANIC COMPOUNDS BY PRODUCED CERIC ION. Takeo Takahashi and Hiroshi Sakurai. Translated from Kogyo Kagaku Zasshi, 63: 608-11(Apr. 1960). 15p.

Reducible organic compounds such as oxalic acid, β-naphthylamine, and aniline which react too slowly by the ceric ion to permit direct coulometric titration can be determined by first producing ceric ions in excess by electrolytically oxidizing with a solution mixture of cerous sulfate and ferric ammonium sulfate; next by adding the samples and completing the reaction at normal temperature or at high temperature; and then by electrolytically reducing the remaining ceric ions and measuring the ceric ions which were consumed in the oxidation of the organic compound. Employing this method, minute quantities of β-naphthylamine, aniline, and phenol were determined at normal temperature, and of oxalic acid, d-mannitol, and d-sorbitol were determined at high temperatures. The hydroxy acid formed when sodium glutamate was treated with nitrous acid could be determined by this method. Regeneration methods for the electrolyte were studied. (auth)

8683 RADIOCHEMICAL DETERMINATION OF POLYTHIONATES. Nils-Herman Schöön (Chalmers Tekniska Högskola, Goteborg). Acta Chem. Scand., 14: 2009-20 (1960). (In English)

Two radiochemical methods were developed for the determination of polythionates. In the first method, the polythionates are reacted with sulfite and with a mixture of sulfite and sulfide. The thiosulfate formed in these reac-

tions is then determined with $Ag^{110}SCN$. In the second method, the sulfide contains the radioactive isotope S^{35} and the amount of radioactive thiosulfate formed is instead determined. A correction must be applied for the amount of radioactive thiosulfate formed by isotopic exchange between the sulfide and thiosulfate. (auth)

8684 NEW METHODS FOR THE DETERMINATION OF FREE ACID IN THE PRESENCE OF LARGE AMOUNTS OF URANYL SALT. Sten Ahrland (Eurochemic, Mol-Donk, Belg.). Acta Chem. Scand., 14: 2035-45(1960). (In English)

Two new methods were developed for the determination of free acid in solutions containing large amounts of uranyl salt. Both methods are based on the weakening of the acidic properties of the uranyl ion, which is brought about by its bonding to sulfate ions. By utilizing this complex formation it is in fact possible to arrive at a titration curve of two distinct steps. According to the first method, the free acid is determined by potentiometric titration to the well determinable point of inflection between these steps. For low concentrations of acid, however, when a titration is not practical, the free acid is instead determined by direct measurement of pH, according to the second method described. (auth)

8685 AUTOMATIC TECHNIQUES OF AIRBORNE PARTICLE COUNTING. PART II. A. Lieberman and J. Stockham (Armour Research Foundation, Chicago). Air Eng., 3: 37-9(Jan. 1961).

An automatic particle counter was used to examine the atmosphere in an ultra-clean room (White Room, Sperry Farragut plant, Bristol, Tenn.) under simulated repackaging and sonic degreasing conditions. The concentration and size distribution of the dust particles in the room atmosphere were determined, and the recovery time of the room from high dust conditions was measured. (D.L.C.)

8686 TRACE ANALYSIS BY COMBINATION OF ION EXCHANGE AND X-RAY FLUORESCENCE. DETERMINATION OF URANIUM IN SULFATE EFFLUENTS. J. N. Van Niekerk, J. F. De Wet, and F. T. Wybenga (National Physical Research Lab., Pretoria). Anal. Chem., 33: 213-15(Feb. 1961).

A method is described for the rapid determination of uranium, at concentrations of a few parts per million, in barren uranium leach liquors from the uranium industry. Since these concentrations are too low for direct x-ray fluorescent analysis, the uranium is first concentrated on a suitable anionic exchange resin, which is then analyzed directly on an x-ray spectrograph. In rapidity and accuracy the method compares very favorably with other methods currently in use. On extending the method to cationic resins, this technique promises to extend the scope of x-ray fluorescent analysis far beyond its present limits. (auth)

8687 RESOLUTION OF TIME-DEPENDENT GAMMA SPECTRA WITH A DIGITAL COMPUTER AND ITS USE IN ACTIVATION ANALYSIS. Oswald U. Anders and William H. Beamer (Dow Chemical Co., Midland, Mich.). Anal. Chem., 33: 226-30(Feb. 1961).

Recent developments in activation analysis emphasize completely instrumental methods employing γ-ray spectrometry. For such analyses data handling is a problem. To make better use of the obtainable data a small electronic digital computer was programmed to correct, normalize, and resolve time dependent γ spectra from short-irradiation-time neutron-activation samples. Its use permits obtaining maximum information from mixed γ spectra and freedom from simultaneous irradiation of elemental standards. Typical analyses using 5-min irradiations are given and the peeling technique used is described. Reference spectra were collected and are available for 69 elements. (auth)

8688 NEUTRON ACTIVATION METHOD FOR THE DETERMINATION OF TRACES OF CADMIUM IN ALUMINUM. Enzo Ricci and W. D. MacKintosh (Atomic Energy of Canada Ltd., Chalk River, Ont.). Anal. Chem., 33: 230-3(1961) Feb.

Cadmium in high-purity aluminum was determined in the 1-ppb range by neutron-activation analysis. The method was developed specifically for the analysis of aluminum intended for use in reactor cores. Simultaneous irradiations of samples and comparative standards were carried out in the NRX reactor, Chalk River. The induced radioactivity derived from the cadmium impurity was separated from the matrix by ion exchange and purified by precipitation using carriers. The purified radioisotopes of cadmium were then counted to determine the amount of induced radioactivity and the concentration of cadmium in the sample was calculated from the counting results. A sensitivity of 17 ppb was readily obtained. The relative standard deviation was $\pm 9.4\%$. As the half life of the radioactivity involved is moderately long (53 hr), the analysis need not be made at a reactor site. (auth)

8689 SEPARATION OF RADIOACTIVE ZINC FROM REACTOR COOLING WATER BY AN ISOTOPE EXCHANGE METHOD. W. B. Silker (General Electric Co., Richland, Wash.). Anal. Chem., 33: 233-5(Feb. 1961).

A method was developed to separate radioactive zinc from reactor cooling water by isotope exchange with inert zinc in the form of zinc amalgam. The radioactive zinc was recovered in high yield and free from all other activities except Cu^{64} and traces of Mn^{56} by a single contact with zinc amalgam. The Cu^{64} interference could be removed quantitatively by a pre-extraction into cadmium amalgam. The procedure is rapid and simple enough to warrant application to an automatic analyzer for continuous measurement of radioactive zinc in waste streams. (auth)

8690 SOLVENT EXTRACTION METHOD FOR THE RADIOCHEMICAL DETERMINATION OF ZINC. William J. Maeck, Maxine Elliott Kussy, and James E. Rein (Phillips Petroleum Co., Idaho Falls, Idaho). Anal. Chem., 33: 235-6(Feb. 1961).

This method for the determination of radioactive zinc in fission-product mixtures is based on strong base scavenging of basic medium insoluble ions with amphoteric zinc remaining in solution, followed by solvent extraction of the diethyldithiocarbamate complex into ethyl acetate. Zinc was removed from the organic phase by stripping with dilute hydrochloric acid. The yield determination was based on an EDTA titration with Eriochrome Black T indicator. Counting was done in a well-type NaI(Tl) scintillation crystal. The method was evaluated by measuring the fission yield of Zn^{72} in a thermal neutron-irradiated sample of U^{235}. A value of $2.6 \times 10^{-5}\%$ is reported. (auth)

8691 RADIOCHEMICAL DETERMINATION OF MOLYBDENUM BY SOLVENT EXTRACTION. William J. Maeck, Maxine Elliott Kussy, and James E. Rein (Phillips Petroleum Co., Idaho Falls, Idaho). Anal. Chem., 33: 237-8(Feb. 1961).

This method for the determination of Mo^{99} is based on the extraction of the α-benzoinoxime complex into ethyl acetate with subsequent stripping into dilute hydrochloric acid. The extraction circumvents the inconvenient perchloric acid wet oxidation of the precipitated complex as used in prevailing methods. Advantages of the proposed method

are excellent decontamination, decreased analysis time, and greater safety. The half life value of Mo^{99}, based on this method, is 66.55 ± 0.22 hr. (auth)

8692 SPECTROPHOTOMETRIC DETERMINATION OF CHROMIUM IN URANIUM WITH 8-HYDROXYQUINALDINE. Kenji Motojima and Hiroshi Hashitani (Japan Atomic Energy Research Inst., Ibaraki-ken, Japan). Anal. Chem., 33: 239-42(Feb. 1961).

An analytical procedure for the spectrophotometric determination of microgram quantities of chromium in uranium, based on the extraction of the 8-hydroxyquinaldine (2-methyl-8-quinolinol) complex with chloroform and photometry of the extract, is described. Extraction of uranium was prevented by the use of acetic acid as a masking agent. The behaviors of the common ions were investigated. To eliminate the interference of iron and other elements, the chloroform extract was washed with a carbonate-cyanide-hydroxylamine mixture. The proposed method is precise and accurate, and is useful for the determination of down to 1 ppm of chromium in uranium. (auth)

8693 PRECISE DIFFERENCE METHOD FOR THE SPECTROPHOTOMETRIC DETERMINATION OF CERIUM(IV) AT MICROMOLAR CONCENTRATIONS. L. A. Blatz (Los Alamos Scientific Lab., N. Mex.). Anal. Chem., 33: 249-52(Feb. 1961).

In a cation resin exchange study of the sulfate ion complexes of cerous ion, a precise analytical spectrophotometric method for determination of cerium in the range of 5 to 12×10^{-6} M was necessary. Existing methods were modified by introduction of a difference method involving reduction of cerium(IV) to cerium(III) and studies were made of the factors influencing precision, such as suspended material, presence of organic (reducing) material, purification of reagents and solutions, cell constants, stray light of the spectrophotometer, interfering substances, optimum concentrations of all reagents, time factors, and blank corrections. The molar absorptivities at 320, 340, and 360 mμ were 5.92×10^3, 5.12×10^3, and 3.52×10^3. Reproducibility checks revealed a probable error of a single determination of about 0.25% at each wavelength. Iron, thorium, uranium, neodymium, zirconium, nitrate ion, and excess persulfate ion did not interfere. Other possible interferences are discussed. Beer's law is obeyed within the limits of the precision obtained. (auth)

8694 INDIRECT DETERMINATION OF SULFATE BY NONAQUEOUS TITRIMETRY. Gerald Goldstein, Oscar Menis, and D. L. Manning (Oak Ridge National Lab., Tenn.). Anal. Chem., 33: 266-8(Feb. 1961).

A method was developed for the rapid determination of sulfate in the presence of ions such as uranyl and ferric, which interfere in most conventional methods. Sulfate was precipitated by the addition of excess barium acetate. The excess barium acetate was then determined by potentiometric titration with perchloric acid in an acetic acid medium. Both cationic and anionic interferences were evaluated. This method was applied to the determination of total sulfate in solutions of reactor fuels which contained primarily uranyl and copper sulfates and free sulfuric acid. A precision of better than 1% was obtained in replicate titrations. The results were in good agreement with the known values for synthetic samples and with the values obtained by a cation exchange–barium chloride titration procedure for actual samples. (auth)

8695 DETERMINATION OF CESIUM AS PERMANGANATE. Earle R. Caley and Wallace H. Deebel (Ohio State Univ., Columbus). Anal. Chem., 33: 309-10(Feb. 1961).

The possibility of almost quantitative precipitation of cesium permanganate in a sufficiently concentrated cesium solution at a low temperature in the presence of a sufficiently high concentration of permanganate was investigated. CsCl and NH_4MnO_4 were used in the tests, but sodium or lithium permanganate were also found to be suitable. The results were satisfactory if the concentrations of permanganate and cesium were sufficiently high. Rubidium impurities caused a positive error due to coprecipitation. (M.C.G.)

8696 POLAROGRAPHIC DETERMINATION OF IODINE IN TELLURIUM METAL. V. T. Athavale, R. G. Dhaneshwar, S. V. Gulavane, and M. S. Varde (Atomic Energy Establishment, Trombay, India). Anal. Chem., 33: 311-12(Feb. 1961).

The determination of iodine in tellurium was investigated. The iodine in the sample was oxidized, subsequently reduced, and distilled. The distilled iodine was absorbed in an alkali solution, extracted in carbon tetrachloride, and then back-extracted into the aqueous phase. Sodium hydroxide solution was added, and using potassium chloride and borax as a supporting electrolyte, the iodate in this solution was determined polarographically. Iodine recoveries, tested by adding known amounts of iodine to pure tellurium, ranged from 96 to 100%. (M.C.G.)

8697 RADIOCHEMICAL DETERMINATION OF RADIUM IN URANIUM MILLING PROCESS SAMPLES. Henry G. Petrow and Robert Lindstrom (Ionics, Inc., Cambridge, Mass.). Anal. Chem., 33: 313-14(Feb. 1961).

The determination of total radium in uranium mill process samples proposed by Petrow, Nietzel, and De Sesa was modified to increase sensitivity. To decrease the quantity of inert material accompanying radium, ammonium carbonate was substituted for sodium carbonate as the reagent for converting lead sulfate to lead carbonate. The change increased the yield from 77 to 95%. The second change involved the use of solvent extraction rather than ion exchange to bring about lead-radium separation. Aliquat 336, a quaternary amine, was used as the extractant, and the lead was extracted as a chloride complex. This change brought about a considerable reduction in the time necessary for analysis. (M.C.G.)

8698 THE DETERMINATION OF TRACE ELEMENTS BY FAST-NEUTRON ACTIVATION ANALYSIS. R. F. Coleman (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Analyst, 86: 39-44(Jan. 1961).

The use of fast neutrons in trace analysis is described. Details are given of a method of producing a large flux of 14.5-Mev neutrons suitable for activation analysis; the cost is about £20,000. Suitable reactions, together with cross sections and probable limits of detection, are quoted for nearly all the elements of the periodic table. (auth)

8699 AN INVESTIGATION OF THE BENZOIN METHOD FOR THE FLUORIMETRIC DETERMINATION OF BORON. G. Elliott and J. A. Radley (Radley Industrial Research and Development Labs., Reading, Berks, Eng.). Analyst, 86: 62-9(Jan. 1961).

The development of the boron–benzoin fluorescence at microgram concentrations of boron was investigated; a simple, but sensitive, fluorimeter was used. The development and decay of fluorescence intensity with time were observed in various solvents in the presence of different basic compounds. The fluorescence produced when formamide and its N-derivatives are used as the solvent media is stronger than that found when ethanol is used. A glycine buffer solution of pH 12.8 is effective in producing the correct conditions for developing fluorescence with ethanol as

solvent, but is not effective in the formamide series of solvents. Isopropylamine and isobutylamine are effective bases in both ethanol and the formamide series. For a series of solvents of a given chemical type, e.g., the formamides, there may be an increase in fluorescence intensity with dielectric constant, although this is not true for the alcohols. Oxygen has a pronounced inhibiting action on the development of fluorescence in ethanol, but has much less effect in formamide. There is a linear relationship between fluorescence intensity and amount of boron present in the range studied (0.05 to 0.5 μg). (auth)

8700 TECHNIQUES FOR DETERMINATION OF URANIUM. APPLICATIONS TO PERSONNEL MONITORING. L. Vidal, R. Platzer, J. Toulet, and G. Hugot (Centre d'Etudes Nucleaires, Saclay, France). Arch. maladies profess. méd. travail et sécurité sociale, 21: 134-9(1960). (In French)

Two medical analysis methods are useful in determination of uranium in personnel: α-detection methods where enriched uranium is involved and the radiation dose is needed and the fluorimetric method for a fast, efficient method for natural uranium. These methods are described and discussed. (T.R.H.)

8701 RAPID DETERMINATION OF THORIUM BY FLUORIDE TITRATION USING SOME CHROMOTROPIC AZO DYES. Sachindra Kumar Datta (Victoria Coll., Coochbehar, India). Bull. Chem. Soc. Japan, 33: 882-4 (July 1960). (In English)

The thorium-chromotropic azo dye complexes are found to be fast-reacting with fluorides, in which exchange of dye molecule for fluoride ion takes place. The colored thorium-dye complexes are thereby decomposed with the liberation of the free dye and formation of thorium fluoride. The color changes at the end point enable visual comparison. Three dyes: nitroso-SNADNS-4, SNADNS-6, and CHPADNS were used as thorium complexing agents or indicators. The color change with the nitroso-SNADNS-4 at the end point is very sharp. Titrations are best carried out at pH range 2.4 to 2.8 and thorium present should not be more than 50 mg per 50 ml solution. With the increased precipitation of thorium fluoride the dyes are adsorbed in the precipitate and the end point becomes more obscured. Microgram amounts of thorium may be determined by this method. A large number of cations and anions interfere in the process, of which the most important are: iron, cerium, rare earth elements, alkaline earth elements, phosphates, borates, oxalates, tartrates, and citrates. This method is best applicable to thorium solutions from which the interfering elements have been removed. (auth)

8702 THE DETERMINATION OF ZIRCONIUM WITH BENZOYLPHENYLHYDROXYLAMINE. D. E. Ryan (Dalhousie Univ., Halifax, Nova Scotia). Can. J. Chem., 38: 2488-92(Dec. 1960).

Zirconium is completely precipitated by benzoylphenylhydroxylamine from 0.5N acid solutions. The complex formed in sulfuric acid solutions has a constant composition, $Zr(C_{13}H_{10}O_2N)_4$, and is used for the direct weighing of zirconium; the factor is 0.0970. The product precipitated from hydrochloric acid solutions must be ignited to the oxide. The reaction is sensitive, 1 ppm of zirconium being detectable, and quantitative determination of 0.2 mg is possible. Thorium and the rare earths do not interfere. (auth)

8703 THE USE OF RADIOACTIVE ISOTOPES IN INVESTIGATING THE DISTRIBUTION OF ATOMS IN A CONSTANT CURRENT ARC PLASMA WITH VARIOUS ATMOSPHERES. E. E. Vaĭnshteĭn and Yu. I. Belyaev. Doklady Akad. Nauk, S.S.S.R., 134: 322-5(Sept. 11, 1960). (In Russian)

Tagged atoms were used to investigate the role of the carriers Ga_2O_3 and AgCl (2%) in UO_2 to detect various impurities. If the effect of the carrier is to concentrate the impurity atoms in the arc flame, this effect can be observed by using a tagged impurity and noting the increase in radioactivity in the arc flame with the use of Ga_2O_3 or AgCl as a carrier in samples of UO_2. The effect of the atmosphere surrounding the arc is important. Thus it was found with the use of Ta^{182} and Na^{24} tracers that there is a definite shift in the spatial distribution of tantalum and sodium on going from an air atmosphere to a helium atmosphere. The use of Ga^{72} and Ag^{110} tracers showed that the spatial distribution is shifted so close to the anode for a Ga_2O_3 carrier in a helium atmosphere that the improvement in the sensitivity of determining impurities can be completely lost in a helium atmosphere with Ga_2O_3 as a carrier. The use of Fe^{59} tracer in UO_2 showed that the sensitivity of the determination is 3 to 4 higher with Ga_2O_3 or AgCl as a carrier in an atmosphere of air than it is without a carrier. The sensitivity decreased somewhat for an argon atmosphere and fell drastically in a helium atmosphere. (TTT)

8704 THE DETERMINATION OF TANTALUM AS A CONTAMINANT IN ZIRCONIUM, HAFNIUM AND NIOBIUM. R. S. Pauer and N. S. Poluektov (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Ind. Lab. (English Translation), 25: 938-40(Aug. 1959).

Tantalum was determined photocolorimetrically, by means of the color of the benzene extract of the fluorotantalate of methyl violet, in hafnium, niobium, and zirconium. The maximum benzene extraction of tantalum was obtained with a hydrofluoric acid concentration of 0.3N with the addition of 0.04% methyl violet, at pH 2.3. The fluorine complex of niobium with methyl violet was extracted by benzene, but only to a slight extent. This extracted niobium could be re-extracted with hydrofluoric acid containing methyl violet. The loss in color intensity, caused by washing, was corrected for by means of a specially constructed curve. (M.C.G.)

8705 METHODS OF SEPARATION IN THE ANALYSIS OF MIXTURES OF IMPORTANT FISSION ELEMENTS. REVIEW. Yaromin Bar. Ind. Lab. (English Translation), 25: 952-64(Aug. 1959).

Methods of separation of fission products for analysis, including coprecipitation, extraction with organic solvents, distillation, electrodeposition, and chromatography are discussed. Identification of these fission products and determination of their activities by means of a scintillation γ spectrometer are also described. (M.C.G.)

8706 A SPECTROGRAPHIC METHOD FOR DETERMINING IMPURITIES IN HIGH-PURITY CARBONS AND GRAPHITES. A. A. Demidov and L. B. Gorbunova. Ind. Lab. (English Translation), 25: 998-9(Aug. 1959).

For the determination of Al, Fe, Mg, Mn, and Si in high-purity carbon and graphite, the method of concentrating impurities proposed by Karabash and Peizulaer was used. The graphite was mixed with beryllium oxide as a collector, burned, and all the ash impurities were concentrated on the collector. The beryllium oxide was then analyzed spectrographically for the impurities. These could be determined down to concentrations of 10^{-3} to 10^{-5}% in the original material. (M.C.G.)

8707 SPECTROGRAPHIC ANALYSIS OF PREPARATIONS OF RARE EARTHS OF THE CERIUM GROUP FOR

SAMARIUM. V. L. Kustas and G. V. Lazebnaya. Ind. Lab. (English Translation), 25: 999-1000(Aug. 1959).

A spectrographic method for determining samarium in compounds of Ce, La, Pr, and Nd is described. The sample, in the form of a 0.05 to 25% solution, was applied to the tip of a graphite electrode which was previously treated with a 3% solution of polystyrene in benzene. The mean relative error for the determination of samarium in cerium was ±4.2%, in lanthanum ±1.3%, in neodymium ±2.5%, and in praseodymium ±3.3%. (M.C.G.)

8708 THE PHOTOCOLORIMETRIC DETERMINATION OF SILICON IN ZIRCONIUM. S. V. Elinson and L. I. Pobedina. Ind. Lab. (English Translation), 25: 945-6(1959).

A method for determining silicon in zirconium and its alloys is given based on the optical density of a solution of the silicomolybdic heteropoly acid reduced to the blue complex by ascorbic acid. The precision of the method, characterized by the rms variation, was determined by analysis of 12 samples of the same alloy containing 0.1% silicon and was found to be ±7.2%. (T.R.H.)

8709 ACTIVATION ANALYSIS OF MERCURY. T. Westermark and B. Sjöstrand (Royal Inst. of Tech., Stockholm). Intern. J. Appl. Radiation and Isotopes, 9: 1-15(Dec. 1960). (In English)

For the activation analysis of mercury, Hg^{197}, with a 65-hr half life, 68-kev x quanta, and 77-kev γ quanta was selected. It was found that evaporation is serious even if certain precautions are taken. All samples were therefore sealed in quartz tubes. Gamma spectra were, after aging, recorded without breaking the tubes. The sensitivity limit is, at neutron flux 10^{12} neutrons/cm^2 sec, about 0.03 μg. In the parts-per-million region and higher, a 5 to 10% maximum error is typical. The method was applied to several hundred samples comprising biological tissue, blood feces, cellulose, paper, seed grains, pharmaceutical products, historical remains, aluminum, and aluminum corrosion products. It is probably less practical than the gas spectrophotometric method for cellulose and water but might be a practical suggestion for biological samples and aluminum products and, of course, for various sorts of comparisons with other analytical methods for mercury at low levels. (auth)

8710 ACTIVATION ANALYSIS OF CADMIUM IN SMALL BIOPSY SAMPLES. T. Westermark and B. Sjöstrand (Royal Inst. of Tech., Stockholm). Intern. J. Appl. Radiation and Isotopes, 9: 78-83(Dec. 1960). (In English)

Biopsy samples of human kidney, comprising only 2 to 15 mg each, were successfully analyzed for cadmium by activation analysis. The procedure adopted was: after reactor irradiation and dissolution, a sulfide precipitation was treated by alkali. For accurate work a final phosphate precipitation is used but in many cases the first precipitate is studied directly by means of a γ-scintillation spectrometer and multichannel analyzer. (auth)

8711 IONIZATION CURRENT MEASUREMENT OF AQUEOUS SOLUTIONS CONTAINING C^{14}. P. H. Springell (Commonwealth Scientific and Industrial Research Organization, Melbourne). Intern. J. Appl. Radiation and Isotopes, 9: 88-93(Dec. 1960). (In English)

Reproducible ionization current measurement of aqueous solutions containing C^{14} can be achieved by standardizing the sample position and thickness and eliminating or reducing evaporation. A brief comparison is made with other methods used in the measurement of soft β-emitters in aqueous solution, and the advantages of ionization current measurement are outlined. (auth)

8712 A SIMPLE METHOD OF ESTIMATING THE TRITIUM CONTENT OF BIOLOGICAL SAMPLES. G. G. Steel (Inst. of Cancer Research, Belmont, Surrey, Eng.). Intern. J. Appl. Radiation and Isotopes, 9: 94-9(Dec. 1960). (In English)

A quick and simple method of sample preparation is described for the determination of H^3 in biological samples by liquid scintillation counting. The method involves combustion by copper oxide alone in expendable pyrex glass envelopes and can be used for up to 100 mg of sample. The method is applicable to wet or dry tissues or to radioactive solutions; for tissue powders it is found to give linear and reproducible results and tests of over-all efficiency indicate that losses are not more than 5%. The liquid scintillation counter used is of original design and has an efficiency of approximately 10%. (auth)

8713 DETERMINATION OF Fe^{55} AND Fe^{59} IN BLOOD. Leif Hallberg and Hans Brise (Univ. of Goteborg). Intern. J. Appl. Radiation and Isotopes, 9: 100-8(Dec. 1960). (In English)

The simultaneous use of the two radio-iron isotopes (Fe^{55} and Fe^{59}) available today offers distinct advantages in studies on iron absorption and metabolism. The greatly differing energy of radiation from these isotopes makes the precision of the double isotope analysis dependent on both the preparation of the sample and on the counting system. As a result of studies on both these steps a method is described in detail. The determinations are performed on electroplated samples in a gas-flow counter using beryllium and platinum absorbers. The method has given very satisfactory results in studies on the absorption and metabolism of iron in humans. (auth)

8714 ASSAY OF $C^{14}O_2$ IN GEIGER COUNTERS. I. S. Boyce and J. F. Cameron (Wantage Radiation Lab., Berks, Eng.). Intern. J. Appl. Radiation and Isotopes, 9: 133-4 (Dec. 1960). (In English)

The possibility of using ethyl alcohol as a quenching and exchange gas in a Geiger counter for assay of $C^{14}O_2$ was investigated. The counter was used with a probe unit of fixed dead time of 400 μsec and had a sensitive volume of 50 ml. The effects of the CO_2 partial pressure with an alcohol pressure of 1 cm on the count were studied; CO_2 pressures of 10 to 15 cm were found to be optimal. The reproducibility of this method of assay of pure $C^{14}O_2$ prepared from labeled barium carbonate was better than 2%, and a procedure for this $C^{14}O_2$ preparation is given. (D.L.C.)

8715 METHODS FOR DETERMINING RADON-222 AND RADIUM-226. Frederick B. Higgins, Jr., Werner N. Grune, Benjamin M. Smith (Georgia Inst. of Tech., Atlanta), and James G. Terrill, Jr. J. Am. Water Works Assoc., 53: 63-74 (Jan. 1961).

A simple, reliable, and reproducible field method for the determination of certain of the naturally occurring radioisotopes in water was developed. The procedures are applicable to the analysis of water supplies, particularly ground waters, during a relatively extensive field sampling program. The analytic procedure studied involved the de-emanation of Rn^{222} from solution and the collection of the gases in an Erlenmeyer flask coated with a powdered, silver-activated zinc sulfide screen, followed by α scintillation counting. Water samples were collected in specially designed glass bubblers. De-emanation was achieved by means of an evacuated Erlenmeyer flask connected to a bubbler. The vacuum was used to produce an upward flow of air through the bubbler, resulting in radon removal from the water and collection in the flask. The analysis was completed by α scintillation counting of the flask, with the

use of a specially designed detection unit. Ra^{226} was also determined with the use of a simple modification of the de-emanation procedure. After de-emanation for radon analysis, the water sample was thoroughly purged of any remaining radon. The bubbler was then sealed for 8 to 12 days to allow the build-up of radon from the radium in the sample. A second radon analysis was performed on the sample, and the radium content was calculated with the use of the known state of partial equilibrium between the two radioelements. (auth)

8716 DETERMINATION OF NEPTUNIUM-239 IN VARIOUS AQUEOUS SAMPLES. Jun Akaishi (Div. of Health Phys., Japan Atomic Energy Res. Inst.). J. At. Energy Soc. Japan, 2: 591-7(1960). (In English)

All neptunium of (IV), (V), and (VI) states in urine is quantitatively coprecipitated onto basic phosphates of calcium and magnesium which are formed when the sample is treated with sodium hydroxide. The determination of neptunium is studied using this coprecipitation procedure. Neptunium can be concentrated by the coprecipitation from large volumes of aqueous samples such as urine, tap water, and sea water. Separation from other radioactive nuclides which are simultaneously coprecipitated onto the precipitate can be attained by the anion exchange. For urine samples basic phosphates of calcium and magnesium were directly precipitated by adding sodium hydroxide solution. For tap water, phosphoric acid and a small amount of the calcium carrier were added in order to carry down neptunium. In the case of sea water, phosphoric acid was added and a small portion of calcium and magnesium phosphates were precipitated by adding a small amount of sodium hydroxide. The precipitate was dissolved with nitric acid. The resultant solution contained 7.5N nitric acid, 0.1M semi-carbazide, and 0.01M ferrous sulfamate. The solution was passed through 1.00 g of Dowex 1 × 8 resin column and washed with the nitric acid-reductant solution, then eluted the adsorbed neptunium with a small amount of 0.2N nitric acid 0.005M ceric sulfate solution. The recoveries of Np^{239} were 97.0 ± 2.6% for 300 ml of human urine, 97.9 ± 3.1% for 1000 ml of tap water, and 96.4 ± 2.2% for 1000 ml of sea water, respectively. (auth)

8717 SEPARATION OF HAFNIUM FROM ZIRCONIUM BY ANION EXCHANGE. John L. Hague and Lawrence A. Machlan. J. Research Natl. Bur. Standards, 65A: 75-7 (Jan.-Feb. 1961).

The results of a systematic survey of the elution of hafnium and zirconium in diluted sulfuric acid and in solutions of hydrochloric and sulfuric acids in water are presented. The data characterize the behavior of the sulfate anion complexes of these elements on a strong quaternary-amine anion-exchange resin column. The possibility of separating these elements is demonstrated. (auth)

8718 THE MEASUREMENT OF CARBON-14 AND TRITIUM ACTIVITIES IN GAS-FILLED GEIGER COUNTERS. W. H. Melhuish (Dept. of Scientific and Industrial Research, Lower Hutt, N. Z.). New Zealand J. Sci., 3: 549-58(Sept. 1960). (In English)

The construction of Geiger counters and a vacuum system for filling them with C^{14}-carbon dioxide or H^3-hydrogen is described. The counters must be quenched electronically. The effect of the pressure of the filling gas and ambient temperature on the counters was investigated. Likely errors are discussed and are found to be consistent with the experimental reproducibility (about ±1%). Samples containing about 4×10^{-3} μc/g carbon and 4×10^{-3} μc/g H^3 at the standard filling pressure (150 mm Hg) gave count rates equal to background (25 c/min). (auth)

8719 ON THE USE OF BREMSSTRAHLUNG FOR THE DETERMINATION OF TRITIUM IN AQUEOUS AND ORGANIC SYSTEMS. T. Westermark, L. Devell, and N. A. Ghanem (Royal Inst. of Tech., Stockholm). Nuclear Instr. & Methods, 9: 141-4(Nov. 1960). (In English)

The bremsstrahlung method for the determination of β radioactivity without γ radiation was extended to the case of H^3. Using cells made from light materials, excellent results and rough agreement with theoretical estimates were obtained for water containing millicurie amounts of H^3. Applications to self-diffusion studies on water and labeling experiments are briefly described. (auth)

8720 NOTE ON THE DETERMINATION OF TRITIUM BY MEANS OF LIQUID SCINTILLATORS AND DC-MEASUREMENTS OF PHOTOMULTIPLIER CURRENTS. Torbjörn Westermark, Björn Grapengiesser, Hans Lindroth, and Nadim Ghanem (Royal Inst. of Tech., Stockholm). Nuclear Instr. & Methods, 9: 357-9(Dec. 1960). (In English)

The possibility of measuring the increase in photomultiplier current when tritium samples (dissolved in scintillators) contained in conventional quartz glass cups are placed in front of the photo-cathode to determine the amount of tritium present is discussed. Both water samples and organic systems were analyzed by this method. The relative sensitivity of tritium determination at various high voltages applied to the photomultiplier tube was determined. The accuracy obtainable was found to be 2 to 5% depending on concentration. (M.C.G.)

8721 THE USE OF GAMMA SPECTROMETRY FOR ANALYSIS OF RADIOACTIVE FALLOUTS IN CRACOW. Tadeusz Florkowski, Ludwik Górski, and Leopold Jurkiewicz (Akademia Górniczo-Hutnicza, Kraków). Nukleonika, 5: 629-34(1960). (In Polish)

The use of γ spectrometry for analysis of radioactive fall-out is described. It permits a better determination of the time and kind of nuclear explosion than measurements of global radioactivity. Spectra of three fallout samples are discussed in detail. (auth)

8722 RADIOACTIVATION ANALYSIS IN A NUCLEAR REACTOR. G. B. Cook (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Pure and Appl. Chem., 1: No. 1, 15-30(1960). (In English)

The factors affecting the sensitivity of radioactivation analysis are analyzed and the technique is described and discussed. The flux and cross sections are not usually known well enough, so a weighed quantity of the element studied is irradiated simultaneously for calibration purposes. After activation two possible procedures may be used. For short-lived products, γ spectrometry can be applied directly. For other products a chemical separation is necessary before γ spectrometry because of the residual activity of the main bulk of the sample. Important sources of error, such as from neutron absorption by the sample, must be considered. The use of fast as well as slow fluxes is of some value in certain determinations. The advantages and disadvantages of the radioactivation method are pointed out. (T.R.H.)

8723 EXPERIENCE IN THE U. S. A. ON THE USE OF RADIOACTIVATION ANALYSIS. G. W. Leddicotte (Oak Ridge National Lab., Tenn.). Pure and Appl. Chem., 1: No. 1, 61-80(1960). (In English)

Information revealed by research in the U. S. using radioactivation is reviewed. The use of the technique at ORNL is treated, and details of the special applications made here are given. In each case the irradiation method is given along with subsequent processing. Apparatus used

and the precision obtained are given. (83 references) (T.R.H.)

8724 RADIOACTIVATION ANALYSIS IN BIOCHEMISTRY AND MEDICINE. J. M. A. Lenihan (Western Regional Hospital Board, Glasgow). Pure and Appl. Chem., 1: No. 1, 81-97(1960). (In English)

The use of activation analysis in human and animal biochemistry is reviewed. The advantages of the method make it useful in odontology, legal medicine, and cancer research. Other methods are too unhandy or not sensitive enough for trace element studies in tissues. Combination of the method with paper chromatography greatly increases its selectivity and sensitivity. A reactor is not required for many uses. Some problems which lend themselves to study by radioactivation methods are examined in detail: I^{127} bound to protein in human blood; metabolism of nickel in man; metabolism of trace elements by cancers; role of manganese in bone formation; role of vanadium in calcification of teeth and prevention of caries; new trace elements in human nutrition; and chronic poisoning by industrial metals. (36 references) (T.R.H.)

8725 ACTIVATION ANALYSIS OF MINOR CONSTITUENTS IN HIGH ALLOY STEELS. J. Hoste (Universiteit, Ghent). Pure and Appl. Chem., 1: No. 1, 99-110(1960). (In English)

It is shown that activation analysis is valuable not only for determination of trace elements but also for determination of very low concentrations in the constitution of very complex substances. The results obtained by the National Bureau of Standards on special steels containing vanadium and tungsten in concentrations from 0.01 to several per cent indicate that the precision and accuracy of the method are equivalent to that of chemical methods, even without a previous chemical separation. A method is described in detail in which an internal standard is used for precise correction of flux irregularities. (T.R.H.)

8726 SYSTEMATIC ANALYSIS OF ZONE-MELTED ALUMINUM AND IRON AFTER IRRADIATION IN ATOMIC PILES. Ph. Albert (Centre National de la Recherche Scientifique, Vitry-sur-Seine, France). Pure and Appl. Chem., 1: No. 1, 111-19(1960). (In French)

Radioactivation analysis has been used in studies on the preparation of metals of high purity, and on the influence of minute amounts of impurities in metals. Since only small quantities of material have been available for examination, a scheme has been developed which permits the separation of a large number of radioisotopes from one analytical sample. Examples are given of the analysis of impurities in specimens of aluminum and iron. (auth)

8727 DETERMINATION OF TRACE ELEMENT DIFFUSION IN QUARTZ AND IN GERMANIUM. G. Leliaert (Centre for Nuclear Energy, Mol., Belg.). Pure and Appl. Chem., 1: No. 1, 121-6(1960). (In English)

Studies of mercury distribution in quartz and phosphorus and arsenic distribution in germanium are described. In the former, the samples and standard were irradiated 7 days at $5 \times 10^{\prime\prime}$ neutrons/cm^2/sec. After dissolution and mercury precipitation the activity was measured on a multichannel RCL 256 γ spectrometer. Above 200 kev Sb^{128} interfered, but at 60 to 85 kev the interference became negligible. The germanium analysis was done with 24-hr irradiation at 10^{12} neutrons/cm^2/sec. Standard samples containing $NH_4H_2PO_4$, $(NH_4)_2SO_4$, As_2O_3, and germanium were also irradiated. The irradiated samples were then dissolved in HNO_3, passed over Dowex-I resin, and arsenic and phosphorus were eluted by HF. The arsenic was precipitated by H_2S and the phosphorus as phosphomolybdate. (T.R.H.)

8728 A METHOD FOR THE DETECTION OF MERCURY BY RADIOACTIVATION ANALYSIS. K. Ljunggren and T. Westermark (Royal Inst. of Tech., Stockholm). Pure and Appl. Chem., 1: No. 1, 127-33(1960). (In English)

A radioactivation analysis method is presented which has been used for determination of mercury in biological samples, aluminum, and cellulose and grains treated by mercury phenylacetate. One of the difficulties encountered in these experiments is the evaporation of mercury in the reactor. This is overcome by sealing the samples in standardized quartz ampoules. (tr-auth)

8729 DETERMINATION OF TANTALUM IN HIGH-TANTALUM FERRO-ALLOYS. D. Gibbons and H. Simpson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Pure and Appl. Chem., 1: No. 1, 135-7(1960).

A rapid method is described for determination of high concentrations of tantalum in iron alloys by neutron activation followed by measurement of a selected γ ray. The sample is irradiated in solution to avoid errors from shielding against neutrons. (tr-auth)

8730 INFILTRATION MEASUREMENT WITH THE NEUTRON MOISTURE PROBE. J. Letey, E. Hsia, R. E. Pelishek, and J. Osborn (Univ. of California, Los Angeles). Soil Sci., 91: 77-83(Feb. 1961).

The moisture neutron probe was used to measure the quantity of water intake and position of wetting front during infiltration into soil artificially packed in a metal container. The increase in soil water in the soil, as measured by the neutron probe, correlated quite well with hook gage readings on water at the surface. The wetting front can be positioned (if the vertical range of the probe is known) by observing changes in readings from initial readings. Some of the advantages and disadvantages of using the neutron probe for infiltration studies are discussed. (auth)

8731 SPECTROGRAPHIC DETERMINATION METHOD FOR V, Nb, AND Zr IN BINARY URANIUM ALLOYS. I. Delespaul and F. Lievens (Centre d'Etudes Nucléaires, Mol, Belg.). Spectrochim. Acta, 16: 1486-8(1960).

A determination method of vanadium, niobium, and zirconium in their binary uranium alloys was investigated. Good results were obtained by direct sparking on metallic samples, covering the concentration range from 0.5 to 20%. A standard deviation of 4.5% was observed. (auth)

8732 ANALYTICAL CHEMISTRY IN NUCLEAR REACTOR TECHNOLOGY. Analysis of Reactor Fuels, Fission-Product Mixtures and Related Materials: Analytical Chemistry of Plutonium and the Transplutonic Elements. Third Conference, Gatlinburg, Tennessee, October 26-29, 1959. Talanta, 6: 3-276(1960).

Thirty-one papers and 10 summaries of papers presented at the Third Conference on Analytical Chemistry in Nuclear Reactor Technology held at Gatlinburg, Tennessee, October 26 to 29, 1959, are given. The papers are grouped into four sections: general, analytical chemistry of fuels, analytical chemistry of plutonium and the transplutonic elements, and the analysis of fission-product mixtures. Twenty-seven of the papers are covered by separate abstracts. Four were previously abstracted for NSA. (M.C.G.)

8733 STANDARDS IN THE NUCLEAR ENERGY PROGRAM. C. J. Rodden (New Brunswick Lab., N. J.). Talanta, 6: 3-19(1960).

The types of standards used in the nuclear energy field

are considered under the heading of chemical, spectrochemical, and isotopic standards. The various fuel materials used as standards, such as uranium, plutonium, thorium, and their compounds, are discussed. In addition, standards of certain nonfuel materials of special interest in certain operations, such as zirconium and boron, are considered. (auth)

8734 THE HIGH-RADIATION-LEVEL ANALYTICAL FACILITY AT THE OAK RIDGE NATIONAL LABORATORY. Calvin E. Lamb (Oak Ridge National Lab., Tenn.). Talanta, 6: 20-7(1960).

Unusual techniques and remotely controlled manipulations are required in carrying out analytical work on highly radioactive materials. In order to isolate highly radioactive materials for analysis and to centralize remotely controlled operations in one area, a concrete structure, called the High-Radiation-Level Analytical Facility, was built at Oak Ridge National Laboratory in 1955. This facility is used for the analysis of samples of radioactivity greater than 1 r/hr at contact; the samples are received from the Power Reactor Fuel Reprocessing Pilot Plant, as well as from many other sources. It consists of a sample-storage cell, seven work cells, a "cold" preparation area, a decontamination area, a receiving dock, and an office. Barytes concrete, in addition to concrete of normal composition, is used in the cell walls to meet different shielding requirements. Zinc bromide solutions are used for shielding in the work-cell windows, and high-density lead glass is used for shielding in the storage-cell window. The facility is provided with Master Slave Manipulators, analytical instruments designed for use by remote control, and special equipment for transporting samples, for continuously monitoring airborne and background radioactivity, for disposing of solid and liquid wastes, and for carrying out decontamination procedures. (auth)

8735 THE DETERMINATION OF IRON IN YTTRIUM. J. O. Hibbits, W. F. Davis, and M. R. Menke (General Elec. Co., Aircraft Nuclear Propulsion Department, Cincinnati, Ohio). Talanta, 6: 28-9(1960).

An improved method for determining iron in yttrium metal or Y_2O_3 was investigated further in order to determine its applicability to a wider range of samples. The method consists essentially of the extraction of Fe^{3+} from a 6M HCl solution into a solution of tri-n-octylphosphine oxide (TOPO) in cyclohexane. The iron is re-extracted into 3M H_2SO_4, an equal volume of HCl is added and the iron is again extracted with TOPO. An aliquot of the extract is used for development of the 1,10-phenanthroline complex. The method is almost specific for iron. Only a few elements interfere, even when present in large quantities, and of these elements all but gallium, tellurium, and silicon produce a warning turbidity in the colored solution. No interference with the determination of 100 μg of iron was caused by 10 mg of Al, Sb^{3+}, As^{3+}, Ba, Be, Bi, B, Cd, Ca, Ce^{3+}, Ce^{4+}, Cr^{3+}, Cr^{6+}, Cs, Co, Cu, Dy, Er, Eu^{3+}, Gd, Ge, Au, Hf, Ho, In, I, Ir, La, Pb, Li, Lu, Mg, Mn^{2+}, Mn^{7+}, Hg^{2+}, Nd, Ni, Nb, Pd, P, Pt, K, Pr, Re^{7+}, Rh, Rb, Sm, Sc, Se^{4+}, Na, Sr, Ta, Tb, Tl, Th, Tm, Sn, Ti, V, Yb, Zn; 5 mg of Si, Zr; 1 mg of Mo, W, Ga; 0.1 mg of Te, or U, or 100 mg of Br or F. (auth)

8736 SOME APPLICATIONS OF HIGH-FREQUENCY TITRIMETRY. D. L. Manning and Oscar Menis (Oak Ridge National Lab., Tenn.). Talanta, 6: 30-41(1960).

A parallel transmission line oscillator operating at 190 Mc/s was demonstrated to be a useful instrument for the performance of high-frequency titrations. The end point is established by graphically recording either the oscillator grid current or the IR drop, which is produced by passing this current through a load resistor, versus the volume of titrant and extrapolating the two segments of the titration graph to a point of intersection. The instrument was utilized for the titration of thorium, free acid, and sulfate in solutions of high ionic strength. The method is of particular value in titrating solutions containing substances which mask the color change of indicators or otherwise interfere with visual titrations. Furthermore, it appears to be adaptable for use in the titration of radioactive materials by remote control. (auth)

8737 X-RAY ABSORPTION EDGE ANALYSIS. H. W. Dunn (Oak Ridge National Lab., Tenn.). Talanta, 6: 42-5 (1960).

Very few industrial laboratories are using the x-ray absorption edge method of analysis at the present time. Without a doubt it will be used much more in the future for it has several advantages over other methods. Probably the greatest advantage is the relative freedom from interferences, both direct and matrix. Most elements will have little or no interference, but a few elements will have a direct interference from the absorption edge of one or two elements. Secondly, a wide range of elements can be determined; it should be possible to determine all elements from chromium on, in the table of atomic numbers. In addition, the precision and accuracy of the method are fairly good. For zirconium a relative standard deviation of 1% was obtained for concentrations down to 1 mg/ml, 3% for 0.2 mg/ml, and 50% for 0.05 mg/ml. Means to improve the precision and accuracy of the method are being planned. The method is also fairly fast. If the sample is in solution, the determination of each element requires from 15 min to 1 hr. Other advantages are that any number of elements can be determined in the same solution, the solution is not consumed or contaminated during the analysis, and only a small amount of solution (0.2 to 2 ml) is required. Disadvantages of the x-ray absorption edge method are that elements of low atomic number cannot be determined by this method and the equipment required is expensive. A satisfactory instrument will cost 15,000 to $20,000. (auth)

8738 X-RAY FLUORESCENCE SPECTROGRAPHIC DETERMINATION OF IMPURITIES AND ALLOYING ELEMENTS IN TANTALUM CONTAINER MATERIALS. E. A. Hakkila and G. R. Waterbury (Los Alamos Scientific Lab., N. Mex.). Talanta, 6: 46-51(1960). (TID-11630)

X-ray fluorescence methods were used for determining Mo, Nb, Th, W, Y, and Zr as impurities or alloying constituents in tantalum and binary tantalum alloys being investigated as container materials for molten plutonium fuels. Various solvents were tested for dissolving tantalum samples, and hydrofluoric acid was found to be the most suitable. Samples were dissolved in hydrofluoric acid and diluted to a known volume. Then the solution was analyzed by means of an x-ray tube with a tungsten target. X-ray tube operating conditions and counting times were selected to give good precision in a minimum time. Effects of impurities and variations in x-ray tube voltage and current, scintillation counter voltage, solvent composition, dilution volume, and count rate were determined. Molybdenum, niobium, and zirconium as impurities in tantalum within the concentration range of 25 to 2000 ppm were determined by means of a line-to-background intensity-ratio method with a precision ranging from 17 ppm at the 25 to 100 ppm level to 43 ppm at the 2000 ppm level. From 0.5 to 10% tungsten in Ta-W alloys was determined with an absolute standard deviation of 0.09% by comparing the intensity ratio of the tungsten $L_{\alpha 1}$ to tungsten $L_{\alpha Compton}$ for the sample with ratios obtained for known standards. Thorium or yt-

trium in binary alloys was determined in the 0.025 to 10% concentration range, using an internal standard procedure. Thorium was added as an internal standard in the determination of yttrium, and yttrium was added as an internal standard in the determination of thorium. Following sample dissolution, the ThF_4 and YF_3 precipitates were separated from the tantalum, dissolved in H_2SO_4, and diluted to volume, and the intensity ratio of the thorium to yttrium lines was measured. Relative standard deviations of 7 and 2%, respectively, were obtained in the 0.025 to 0.1 and 0.1 to 10% concentration ranges for yttrium, and 12 and 3% for thorium in the 0.025 to 0.1 and 0.1 to 10% concentration ranges. (auth)

8739 THE ANALYSIS OF A LIQUID METAL REACTOR FUEL. L. Newman, T. Prach, and H. L. Finston (Brookhaven National Lab., Upton, N. Y.). Talanta, 6: 55-62(1960). (BNL-4442)

A procedure was developed for the analysis of a uranium-molten bismuth fuel containing 1400 ppm of U^{235}, 350 ppm of magnesium, and 250 ppm of zirconium. Analyses were performed for the above elements and for the corrosion products, iron, nickel, chromium, and manganese. The activity of the bismuth is approximately 0.2 r hr^{-1} g^{-1} at 1 ft and contains an approximate α activity of 10^9 d min^{-1} g^{-1} in the form of Po^{210}. The sample was dissolved in 50% nitric acid, whereupon zirconium and iron could be extracted directly by 0.5M 2-thenoyltrifluoroacetone in xylene. The absorbance due to the iron complex was measured directly on the organic phase. The zirconium was stripped into a fluoride solution and determined spectrographically. For magnesium and the remaining corrosion products, an aliquot of the original solution was diluted tenfold. The polonium along with the bismuth was extracted by a 0.5M solution of the acid chloride form of tri-iso-octylamine in methyl isobutyl ketone. Three contacts were sufficient to reduce a solution originally containing α activity of 10^7 to less than 10^3 d min^{-1} ml^{-1}. To decontaminate the aqueous solution from rare-earth elements, a praseodymium fluoride precipitation was used. Finally, to decontaminate from the alkali and alkaline earth elements, bismuth hydroxide was used to coprecipitate the magnesium and corrosion products. This precipitate was then dissolved in such a way that the usual matrix for spectrographic analysis was obtained. Uranium was determined in a separate aliquot by a modified dibenzoyl methane method; 1,2-diaminocyclohexane-tetra-acetic acid was used to chelate the bismuth and other interfering materials. After adjustment of the pH to between 6 and 7, the uranium dibenzoyl methane complex was extracted into amyl acetate. An adequate decontamination was thus obtained. (auth)

8740 A METHOD OF URANIUM ISOTOPE ANALYSIS BY DIRECT READING EMISSION SPECTROSCOPY. Jason L. Saunderson (Baird-Atomic Inc., Cambridge, Mass.). Talanta, 6: 63-70(1960).

A special-purpose direct-reading spectrometer was developed for the determination of U^{235}, U^{236}, and U^{238}, using the spectral lines at 4244.12, 4244.22, and 4244.37 A, respectively. The parallel-channel integrating method was used, in which the ratios of U^{235} and U^{236} to U^{238} were determined simultaneously. A 5-amp 2400-A a-c arc was used, the sample (uranium oxide) being held in a graphite crater. The three spectral lines were separated by optical means; exact optical alignment was maintained automatically. At 3% concentration of U^{235}, a coefficient of variation of 1% of the amount present was achieved. The sensitivity for U^{234} was better than 0.1%. Sample preparation was simple and straightforward. Less than 3 min is required for an analysis. (auth)

8741 DETERMINATION OF U^{235} BURN-UP IN IRRADIATED NATURAL URANIUM BY CHEMICAL AND COUNTING METHODS. D. R. MacKenzie (Brookhaven National Lab., Upton, N. Y.). Talanta, 6: 72-93(1960).

A method was desired for determining, with a precision of 1%, the U^{235} content of uranium samples taken lengthwise of a highly irradiated NRX natural uranium fuel rod. A mass spectrometric method capable of achieving this accuracy was not available at the time this work was begun. The method chosen was based on measurements of the fission and α-counting rates of natural uranium samples and uranium samples from the fuel rod after chemical purification, in order to compare their U^{235} : U^{238} ratios. Owing to the thin sources necessary for the counting, the time required for the direct determination of U^{238} by α-counting was too long to be practical. An indirect measure of the U^{238} content was, therefore, obtained by counting the Pu^{239} produced by neutron irradiation of the sources in a position of high flux in NRX. To ensure a valid basis for comparison of samples, all irradiation and counting was done with a source of natural uranium and one of depleted uranium placed back to back. The sources were not disturbed on changing from fission- to α-counting. This type of counting was accomplished by use of an ion chamber with a double grid, located at the opening of a thermal-neutron beam hole. Fission counting was done with the beam hole shutter open; α-counting was done with the shutter closed, a higher gas pressure in the chamber, and a higher electronic gain. Because of difficulties caused by radiation damage to the sources, it did not appear possible to approach the precision desired for U^{235} burn-up values, and a further complexity had to be introduced into the method. The new procedure consisted of five steps. A set of sources and a set of targets were prepared from natural uranium and each depleted uranium sample. The sources were designed for the determination of U^{235} by fission counting; the targets, after processing, were used for the determination of U^{238} via Pu^{239}. Each set of sources and corresponding targets contained Pu^{238}, which was added as a tracer. For any given uranium sample, sources and targets were prepared at the same time and in a manner designed to maintain the Pu^{238} : U^{238} ratio constant for both sets. Sources were fission- and α-counted in the gridded ion chamber to obtain U^{235} : Pu^{238} ratios. Targets were irradiated in the back-to-back arrangement used previously. After irradiation, the uranium and plutonium were dissolved off the aluminum target backing and the plutonium was carefully purified. This plutonium was used to prepare sources on platinum for α pulse height analysis which gave Pu^{239} : Pu^{238} ratios directly and thus, indirectly, U^{238} : Pu^{238} ratios. From these and the U^{235} : Pu^{238} ratios obtained, U^{235} : U^{238} ratios were calculated. The use of an α-active tracer was necessary to link the two sets of counting results. The advantage of using Pu^{238} as a tracer was that the method is independent of chemical yields during the processing of irradiated samples. The precision of the counting methods used for burn-up measurements varied from 1.3 to 2.6%. Before the chemical and counting methods were worked out, a satisfactory mass spectrometric method was developed and put into routine use. The precision of the mass spectrometer measurements, for samples which were analyzed by the counting techniques, varied from 0.5 to 1.4%. Results obtained by analysis with the mass spectrometer and the counting methods agreed within the experimental errors listed above. (auth)

8742 ANALYTICAL METHODS USED IN A STUDY OF REACTIVITY CHANGES WITH LONG IRRADIATIONS. R. G. Hart, C. B. Bigham, and M. Lounsbury (Atomic En-

ergy of Canada Ltd., Chalk River Project, Chalk River, Ont.). Talanta, 6: 94-9(1960).

A number of samples of natural uranium were irradiated to various levels, up to 6200 Mwd/ton, in the NRX reactor at Chalk River for studies of the variation of reactivity with neutron irradiation. Measurements of the reactivity of the samples before and after irradiation were made in the GLEEP reactor at Harwell. Chemical and mass spectrometric analyses of the samples were made at Chalk River. The analytical methods used are discussed. The uranium was determined gravimetrically by diuranate precipitation and volumetrically by $Ce(SO_4)_2$ titration. These methods are straightforward and are mentioned only briefly. Plutonium was determined by four different methods: spectrophotometric, direct low-geometry α-counting, isotopic dilution with highly irradiated Pu, and isotopic dilution with Pu^{238}. A comparison of these methods is given. Some brief comments are also given on reactivity changes with long periods of irradiation. (auth)

8743 THE COLORIMETRIC DETERMINATION OF ZIRCONIUM IN PLUTONIUM–URANIUM-'FISSIUM' ALLOYS. R. F. Buchanan, J. P. Hughes, and C. A. A. Bloomquist (Argonne National Lab., Lemont, Ill.). Talanta, 6: 100-104(1960).

This method was developed for the determination of zirconium in plutonium–uranium-'fissium' alloys. A sample of the alloy containing 40 to 100 μg of zirconium in 10N nitric acid was separated from plutonium and from some of the palladium by anion exchange. The effluent was analyzed for plutonium since more than 60 μg would interfere. The ruthenium was removed by fuming with perchloric acid. The uranium and molybdenum do not interfere in reasonable quantities as they exist in this alloy. The alizarin red-S lake was formed in 0.1N nitric acid, and its absorbancy was measured by means of the Beckman Model B spectrophotometer at 520 mμ. The color was stable for several hr and reproducible within 3 to 5% of the amount present. The interference of the alloying constituents and reagents is given. The time required for duplicate analyses was about $3\frac{1}{2}$ hr, and the equipment and techniques used are standard. (auth)

8744 A SIMPLIFIED METHOD FOR RADIOIODINE ANALYSIS. H. M. Eiland (Knolls Atomic Power Lab., Schenectady, N. Y.). Talanta, 6: 112-16(1960).

A radiochemical method of analysis for gross iodine activity in the primary coolant of pressurized water reactors was developed at KAPL. It is based upon the rapid isotopic exchange which occurs under suitable conditions between fission product iodine and the iodine atoms in preformed silver iodide. About 20 ml of the slightly basic coolant is oxidized with sodium hypochlorite. Lanthanum hydroxide is formed by adding lanthanum nitrate to the solution. The lanthanum hydroxide scavenger is removed by filtration, and the solution is acidified and treated with sodium bisulfite to reduce the iodine to an exchangeable form. The solution is then contacted with preformed silver iodide. The silver iodide is removed by filtration, washed, mounted, and counted. The procedure was found to give excellent decontamination from fission products and activated corrosion products which occur in the primary coolant of pressurized water reactors. The recovery of iodine was shown to be 88 ± 5%. During the past year, the procedure was used extensively at KAPL for applications where speed and simplicity were of greater importance than highest accuracy. (auth)

8745 RADIOCHEMICAL ANALYSIS OF REACTOR EFFLUENT WASTE MATERIALS AT HANFORD. R. W. Perkins (Hanford Labs. Operation, Richland, Wash.). Talanta, 6: 117-32(1960).

Analytical procedures are described which were found to be suitable for the measurement of radioisotopes in effluent water and in erosion products deposited from effluent water. The procedures were applied in studying the changes in concentration of radioisotopes in effluent water following reactor start-up and in identifying and measuring the radioisotopes deposited on metal surfaces during operation. The increase in concentration of nine radioisotopes in the effluent water from a chemically cleaned (purged with Turco 4306B) process tube was measured. The concentrations of all radioisotopes studied in the effluent from the purged tube were, with the exception of Na^{24}, less than those removed from the control tube during the first two days of operation by factors of 5 to 100; several of the radioisotopes, including P^{32} and As^{76}, were less than 25% of their normal value 2 weeks after the purge. It was demonstrated by means of this study that radioisotope concentrations increased rather slowly in the effluent water during the $1\frac{1}{2}$-month period of the test. The relative amounts of the 16 radioisotopes in the effluent water, absorbed during a 35-day exposure on aluminum and stainless-steel and carbon-steel surfaces, downstream from both a normal tube and a chemically cleaned tube were measured. The amounts of the majority of the radioisotopes on the aluminum and stainless-steel surfaces downstream from the purged tube were lower by factors of 2 to 7 than the amounts from the control tube. A smaller difference was observed for the carbon-steel samples. The relative affinity of the metal surfaces for the radioisotopes studied was found to vary by a factor of about 3×10^3; the most readily adsorbed radioisotopes being the lanthanides and the least readily adsorbed being Np^{239}. Calculations based on the relative amounts of these 16 radioisotopes indicated that, for a short exposure (35 days), La^{140}, As^{76}, and Cu^{64} are the major short-lived radioisotopes contributing to the γ-ray emission at the rear face of the reactor, while Zn^{65} and Sc^{46} are the major long-lived radioisotopes. For purpose of comparison, measurements were made of radioisotopes adsorbed on original reactor piping after 15 years of exposure. From these measurements, it was shown that La^{140}, As^{76}, and Cu^{64} were still the major short-lived contributors; however, Eu^{152}, Co^{60}, Tb^{160}, and Fe^{59}, in addition to Zn^{65} and Sc^{46}, were important long-lived contributors. (auth)

8746 RADIOCHEMICAL ANALYSIS OF CORROSION PRODUCT MIXTURES FROM HIGH TEMPERATURE PRESSURIZED WATER LOOP SYSTEMS. L. C. Bogar (Bettis Atomic Power Lab., Pittsburgh, Penna.) and C. J. L. Lock. Talanta, 6: 133-43(1960). (WAPD-T-1051)

The various types of samples of activated corrosion products obtained from the high-temperature pressurized water-loop facilities in the NRX reactor and the radiochemical procedures and radioactivity assay methods which are used in analysis of these samples are described. Two of the loops in NRX, namely, the carbon-steel English Electric Corporation "Leo" Loop and the Bettis Atomic Power Laboratory central thimble CR-V Loop, are described with particular attention to their associated sampling facilities: autoclaves and out-pile test sections for corrosion and corrosion product deposition studies, hot and cold corrosion product filters for filtration of insoluble materials, and ion exchange columns for purification of the loop water and the study of the ion-exchange behavior of activated water-borne corrosion and fission products. The types of samples obtained and the method of attack used to separate and isolate specific fractions of the mixed corrosion products are described. In particular, the separation scheme devised is

one which permits the isolation of elements of the first transition series and their associated activated impurities from one another. The separation is basically an anion exchange technique involving the successive elution of carrier-equilibrated species. Resin samples from the loop purification system were attacked in the presence of carriers by either digestion with $H_2SO_4-HNO_3$ or by alkaline fusion. In some cases, corrosion product deposits were assayed directly for activity distribution by means of γ-scintillation spectrometry (differential pulse-height analysis). Application of composite γ-ray spectrum resolution to deposition coupons and pipe samples is described. The radionuclides found in loop water and in unfilterable corrosion products were mainly radiative neutron-capture products of the corroded in-pile and out-pile materials. The main nuclides analyzed were 45.1 days Fe^{59}, 5.25 years Co^{60}, 27.8 days Cr^{51}, 12.8 hours Cu^{64}, 2.58 hours Mn^{56}, 2.56 hours Ni^{65}, 245 days Zn^{65}, and 65 days Zr^{95}. Fast neutron reactions were also observed through the appearance of 300 days Mn^{54} and 72 days Co^{58}. Two radionuclides observed in the water and in solid corrosion products were 60 days Sb^{124} and 2.8 days Sb^{122}. The source of these radionuclides was not positively identified. The corrosion products from the CR-V Loop also contained 253 days Ag^{110m}, 43 days Cd^{115m}, and 50 days In^{114m} arising from the corrosion of an in-pile specimen of a Ag-In-Cd alloy. Radioactivity assay of the purified fractions from separated samples was mainly by γ-ray scintillation spectrometry. Routine activity assay utilizing comparison with standardized differential pulse-height distributions for pure radionuclides was adopted because of the versatility of its use for both separated and gross samples. Conventional end-window β-proportional counting techniques were used for those nuclides with decay modes and energies that preclude γ-ray intensity assay techniques. The complexity of corrosion-product mixtures from in-pile loops required that stringent control be maintained at all phases of the program from the time of sampling to the time radioactivity assay was completed. Several problem areas are discussed. For example large amounts of Fe^{59}-contaminated Co^{60} samples and Zr^{95}-contaminated Mn^{54} were difficult to detect without considerable scrutiny of counting data. Carrier exchange was difficult to effect in some cases: e.g., Zr^{95}-Zr^{N} exchange. The γ-counting data in particular received careful scrutiny. The gravimetric assay of carrier yield was in some cases a doubtful and time-consuming operation; therefore techniques eliminating gravimetric procedures should be explored. (auth)

8747 ANALYTICAL LABORATORIES FOR THE HANDLING OF PLUTONIUM. Charles F. Metz and Glenn R. Waterbury (Los Alamos Scientific Lab., N. Mex.). Talanta, 6: 149-53(1960).

For the safe handling of plutonium in analytical chemical laboratories, equipment is required capable of handling up to 1-g quantities of the radioactive material per analytical sample and the storage of 100-g quantities in the form of unused samples and residues. Special enclosures, known as dryboxes, or glove boxes, were designed for this purpose. The analytical chemistry laboratories at the Los Alamos Scientific Laboratory which are so equipped are described. The philosophy of handling plutonium is also discussed. These boxes are so designed that all required operations in chemical analyses may be performed safely without contamination of the room and with a minimum of risk to the analyst. Included are operations such as weighing, dissolving, precipitation, filtering, evaporating, centrifuging, and igniting of precipitates and also electrometric, polarographic, spectrophotometric, and spectrochemical techniques. The designs of individual boxes are varied to permit various operations, and at the same time they may be arranged interchangeably in circumstances requiring several boxes in a row. For routine and semiroutine analyses, these boxes are arranged for an assembly-line type of operation. The sample to be analyzed is introduced at one end of the assembly, successive steps in the analysis are performed as the sample is moved progressively through the assembly, and the residue is temporarily stored at the other end of the assembly in a suitable container. These boxes are fabricated of stainless steel, with windows of Lucite or safety glass. All metal exposed on the inside is painted with a strippable plastic-base paint. Glove ports are located at a convenient height to permit easy use of rubber gloves. Experience has shown that plutonium in solution can be safely handled in these enclosures without rubber gloves being on the ports but that for plutonium in solid form, rubber gloves must be attached to the glove ports. These enclosures are equipped with all the usual laboratory services. Doors between boxes are of an unusual design, vertically operated by compressed air. Provisions are included for the operation of equipment such as centrifuges and pH meters within the boxes, yet permitting their removal in an uncontaminated condition. Ventilation is provided through filters for all gloved boxes. It is so regulated by means of dampers in the exhaust ducts that it does not interfere with operations. In case of open-front boxes, the flow of air is maintained at a minimum face velocity of 100 ft/min. Stainless steel as an exhaust duct material was found to be unsatisfactory, especially for those boxes in which acids are fumed. Polyvinyl plastic was used for the more recently installed ducts and was found to be quite satisfactory. The descriptive material is adequately illustrated by 20 photographs. (auth)

8748 THE HIGH-ALPHA-RADIATION ANALYTICAL FACILITY OF THE OAK RIDGE NATIONAL LABORATORY. J. H. Cooper (Oak Ridge National Lab., Tenn.). Talanta, 6: 154-8(1960).

Originally concentrated plutonium and U^{233} solutions were assayed in the High-Alpha-Radiation Analytical Laboratory and the control analyses associated with the ion-exchange isolation of these solutions were also carried out in this facility. However, during the past few years, the high-alpha-laboratory was also used to provide analytical services for all development programs concerned with the processing of α-emitting materials, such as Np^{237} and Am^{241}. A brief description of the methods of analysis and techniques is presented. Mention is made of some of the special problems that have arisen concerning the handling of α-emitting materials. Future plans for a transplutonic analytical facility are also discussed. (auth)

8749 THE DETERMINATION OF PLUTONIUM BASED ON NATIONAL BUREAU OF STANDARDS POTASSIUM DICHROMATE. C. E. Pietri and J. A. Baglio (New Brunswick Lab., N. J.). Talanta, 6: 159-66(1960).

A description of the design and operation of the New Brunswick Laboratory's plutonium analytical facility is presented. The potentiometric titration of high-purity plutonium is discussed. A new laboratory, using gloved boxes of improved design, was built to study the chemistry of plutonium, develop methods of analysis, and prepare plutonium compounds suitable for standards. The laboratory is equipped for spectrographic, wet-chemical, instrumental, and low-level radiochemical analyses. High-purity plutonium (99.96%) is determined by a potentiometric titration with National Bureau of Standards primary standard $K_2Cr_2O_7$. Plutonium metal dissolved in $4\underline{N}$ H_2SO_4 is reduced

to Pu(III) in a Jones reductor and titrated to Pu(IV) with standard $K_2Cr_2O_7$. Polarized gold electrodes are used to indicate the end-point. A relative standard deviation of 0.04% was obtained for 70- to 141-mg samples. The average results were within 0.01% of the purity of the plutonium metal as determined by spectrographic analysis at Hanford. The advantages of primary standard $K_2Cr_2O_7$ vs. $Ce(SO_4)_2$ as used in other methods are discussed, as well as the detection of the end-point by polarized electrodes vs. the reference-indicator electrode system. (auth)

8750 THE DETERMINATION OF NITROGEN, AMERICIUM, NEPTUNIUM, AND URANIUM IN P.P.M. QUANTITIES IN PURE PLUTONIUM. F. Buchanan, J. P. Hughes, J. J. Hines, and C. A. A. Bloomquist (Argonne National Lab., Lemont, Ill.). Talanta, 6: 173-84(1960).

Methods that were adapted to or developed for the determination of low-level impurities in high-purity plutonium are described. The lower limits of detection are nitrogen, 5 to 10 ppm; americium, 25 ppm; neptunium, 1 ppm; and uranium, 1 ppm. Nitrogen is determined by the classical method in which it is converted to NH_3 in an NaOH solution, distilled into an H_3BO_3 solution, and titrated with standardized HCl. The Kjeldahl apparatus was completely contained in a glove box, and all transfers of waste solution were made by vacuum. After dissolution of the sample, the time required per determination was about 1 hr. The precision of the method was 10% of the amount present. The americium content was calculated from the difference between the per cent of 5.5-Mev α activity before and after the separation of americium from plutonium. The activity of the α energy is determined by pulse-height analysis. The per cent of 5.5-Mev α activity before the separation indicates the sum of Am^{241} and Pu^{238}. The americium was separated from the plutonium in a 12N HCl–0.1N HNO_3 solution by means of an anion-exchange resin. The plutonium was eluted from the resin with 1N HCl, and a sample dried on a platinum disk for pulse-height analysis. A better sample can be prepared for pulse-height analysis by drying some of the activity from the organic phase of a thenoyltrifluoroacetone separation of the eluted plutonium. About 1 man-hour was required per determination. The precision and the accuracy were 10%. The neptunium was extracted from 12N HCl containing 0.1M hydroquinone and 0.1M KI to keep the neptunium in the quadrivalent state and the plutonium in the trivalent state. The organic solvent was 0.5F mono(2-ethylhexyl)ortho-phosphoric acid, with toluene as a diluent. The distribution coefficient for Np^{4+} was greater than 800, while that for $Pu^{3+,4+}$ was about 0.1. The organic phase was washed a sufficient number of times with 12N HCl and 0.1M hydroquinone to effect the desired decontamination from plutonium. The decontamination factor for each wash operation was about 10. The organic phase was adjusted to a volume of 2 ml, and an appropriate aliquot dried on a platinum disk for α pulse analysis. The time required for the determination was 2 man-hours. The precision and accuracy were 10%. The uranium in plutonium was determined in the range of 10 to 1000 ppm. A 5-mg aliquot of plutonium in 1N HNO_3 was reduced to Pu^{3+} with 2M ferrous sulfamate and contacted for 10 min with 30% tri-n-butyl-phosphate in benzene. The organic phase was washed five times with a 1N HNO_3-ferrous sulfamate solution. The organic phase was adjusted to a volume of 1 ml and appropriate microaliquots added to NaF–LiF flux tablets and dried. Then flux tablets containing aliquots of the sample, standards, and standard additions of uranium were fused for reading on the fluorophotometer. The recovery was from 85 to 95% with a precision of 10%. The time required for analysis was about 2 man-hours. (auth)

8751 ELECTRONIC CONTROLLED-POTENTIAL COULOMETRIC TITRATOR FOR PLUTONIUM ANALYSIS. M. T. Kelley, H. C. Jones, and D. J. Fisher (Oak Ridge National Lab., Tenn.). Talanta, 6: 185-8(1960).

An instrument that performs coulometric redox titrations at a controlled-potential is described. A stabilized printed-circuit operational difference amplifier combined with a transistor current amplifier is used to control the potential of the electrode at which the desired reaction occurs. A portion of the electrolysis current is integrated by a stabilized printed-circuit operational amplifier connected as a time integrator, and the integral is read out as a voltage. The instrument is operated completely from an a-c line and can be operated with either manual or automatic cut-off. The calibration is absolute; results are computed from Faraday's law. Accurate coulometric titration of small amounts of substances with high equivalent weights such as plutonium is possible because of the high stability of the integrator. (auth)

8752 X-RAY FLUORESCENCE ANALYSIS OF PLUTONIUM. W. S. Turnley (Dow Chemical Co., Rocky Flats Plant, Denver, Colo.). Talanta, 6: 189-95(1960).

An x-ray fluorescence method, using yttrium as an internal standard, was developed for the quantitative determination of plutonium in high-level solids, in liquids, and in sludges containing plutonium in low concentrations. Handling procedures and sample preparation techniques, as well as equipment, are described. An $Al(OH)_3$-MgO matrix was used for work with solid samples. Liquid samples were analyzed by adding the internal standard to a diluted sample of the liquid and then making the fluorescence measurements. The range of the fluorescence method is from 10 ppm to 100% plutonium for solid samples and from 5 to 250 g/l for liquid samples. Standard deviations between known and observed values were established from analysis of each type of sample. Samples that are almost impossible to analyze by any other method can be analyzed easily and rapidly by the x-ray fluorescence method, which is applicable to plutonium in almost any form and is almost completely free from cationic and anionic interference. (auth)

8753 SPECTROCHEMICAL ANALYSIS OF 'FISSIUM' FOR CERIUM AND LANTHANUM. G. W. Boyes, Jr., J. B. Ramsay, and R. T. Phelps (Los Alamos Scientific Lab., N. Mex.). Talanta, 6: 209-14(1960).

'Fissium' is a synthetic spent plutonium-rich reactor fuel which has a nominal wt.% composition of 2.5 Fe, 0.7 Ce, 1.3 La, 0.7 Mo, 1.3 Ru, and 0.8 Zr. It is used as a stand-in for irradiated fuel in the study of pyrometallurgical methods of treatment for the removal of fission products. To evaluate the cesium and lanthanum contents of the fuel alloy, as well as the by-products of this treatment, a spectrochemical method was developed which has a coefficient of variation of 6% and comparable accuracy when amounts ranging from 40 to 200 μg are determined. The recommended procedure involves the following steps: dissolution of the solid sample in HCl, HNO_3, or $HClO_4$; oxidation of plutonium to the hexavalent state with $HClO_4$; separation of cesium and lanthanum from plutonium and other elements by precipitating them as the fluorides along with europium, which is added as a coprecipitant; conversion to an HCl medium; spectrographic analysis of the sample and a set of standards, utilizing spark excitation with copper electrodes; and photometry of suitable spectral lines, including those of the internal standard, europium, on a calibrated emulsion to evaluate the concentrations by conventional means. After dissolution of the sample, the succeeding steps can be readily completed for six samples in

duplicate by the expenditure of 8 man-hours of work. The least practical amount of element to process is 10 μg. A factorial experiment involving cerium, lanthanum, neodymium, plutonium, and other fissium-element concentrations indicated that bias existed for cerium and lanthanum determinations at the 20-μg level of each, but not at the 50-μg and higher levels. No significant difference was observed when the relative proportions of cerium and lanthanum were varied tenfold in the absence of neodymium. Erratic and incomplete recovery of cerium was noted if the concentration of $HClO_4$ was less than 1N during the F^- precipitation; $HClO_4$ in concentrations up to 3N gave satisfactory results. Processing of standards, both with and without the fission elements, by the recommended procedure yields data which are not significantly different spectrographically from those observed for unprocessed aliquants. (auth)

8754 A QUANTITATIVE DETERMINATION OF SEVERAL SHORT-LIVED IODINE, BARIUM AND STRONTIUM FISSION PRODUCTS IN GAS-COOLED REACTOR EFFLUENTS. Lyle L. Reed, Marcus N. Myers, and William W. Sabol (General Electric Co., Aircraft Nuclear Propulsion Project, Idaho Falls, Idaho). Talanta, 6: 215-29(1960).

Gamma scintillation spectrometry was used as a basis for the quantitative determination of absolute disintegration rate values for I^{131}, I^{132}, I^{133}, I^{134}, I^{135}, Ba^{139}, Ba^{140}, Sr^{91}, and Sr^{92} collected from reactor effluent air on activated coconut charcoal. After chemical separations for the various elements were made, the complex γ spectra resulting were treated mathematically, resulting in the solution of simultaneous linear equations to yield d/m values for the specific isotope. Corrections were made for any absorber between the source and NaI(Tl) crystal, for the total absolute detection efficiency for the counting geometry used, for the peak to total ratios for the particular photopeak, for the decay scheme, and for any internal conversion, thus obviating the need for standard plates of the isotope in question. The method is applicable to γ-emitters in general, providing values for corrections to be applied are available. (auth)

8755 A RADIOCHEMICAL TECHNIQUE FOR DETERMINING FISSIONABLE MATERIAL CONTAMINATION ON COMPLETED REACTOR FUEL ASSEMBLIES. D. G. Miller and M. B. Leboeuf (Knolls Atomic Power Lab., Schenectady, N. Y.). Talanta, 6: 230-6(1960).

A nondestructive method is described for the determination of the extent to which the cladding of reactor fuel assemblies is contaminated with U^{235}. The method involves the irradiation of the assemblies in a test reactor at an extremely low-power level. Subsequent to the irradiation, the fission product (Cs^{138}) is separated by tetraphenylboron extraction. The concentration of this fission product is used as a measure of the extent to which the cladding is contaminated with U^{235}. (auth)

8756 THE SPECTROPHOTOMETRIC DETERMINATION OF ALLOYING AND FISSION PRODUCT ELEMENTS IN NONIRRADIATED PLUTONIUM 'FISSIUM' ALLOYS. Glenn R. Waterbury and Charles F. Metz (Los Alamos Scientific Lab., N. Mex.). Talanta, 6: 237-45(1960). (TID-11633)

In the development of fuel processing methods for purifying Pu–Fe or Pu–Co fuel alloys, methods of chemical analysis were required for the alloying element and representative fission-product elements. The initial plutonium fissium alloy, which represented 10% burn-up after 130 days of fast fission, contained 2.5% Co or -Fe, 0.7% Ce, 1.3% La, 0.7% Mo, 0.03% Nb, 1.3% Ru, and 0.8% Zr. The concentration of many of these elements was reduced in the fuel processing to less than 0.01%. It was necessary to devise chemical methods for determining each element in these concentration ranges except lanthanum, which was determined spectrographically. Dissolution of these alloys was accomplished by a sealed-tube technique, using HCl which contained a few drops of $HClO_4$ as a solvent, or by heating the sample with HCl and $HClO_4$ in a distillation apparatus until the ruthenium distilled as the tetroxide. Cerium was separated from Pu^{6+} by precipitation of Ce^{4+} fluoride, after which it was determined spectrophotometrically as Ce^{4+}. Cobalt was determined in the presence of plutonium by means of the color formed by cobalt in an HCl-acetone medium. Iron was determined by measuring the absorbancy of the ferrous-o-phenanthrolate complex, either in the presence of plutonium or after separation by extraction of $FeCl_3$. Molybdenum and zirconium were each determined colorimetrically as the chloranilates after separation of molybdenum by hexone extraction from HCl solution and precipitation of zirconium as the p-bromomandelate. Niobium was extracted into hexone from an H_2SO_4–HF medium and estimated by means of the color formed with hydroquinone in H_2SO_4. Ruthenium was distilled as the tetroxide and estimated colorimetrically as Ru^{4+} chloride. In the higher concentration ranges, the relative standard deviation for the determination of each element was less than 2%. At lower concentrations, relative standard deviations of 5% were acceptable. (auth)

8757 FISSION-PRODUCT ANALYSIS OF FAST-REACTOR PLUTONIUM FUELS. Jesse W. T. Meadows, George M. Matlack, and Gilbert B. Nelson (Los Alamos Scientific Lab., N. Mex.). Talanta, 6: 246-53(1960).

For the purpose of evaluating the pyrometallurgy program at Los Alamos for the reprocessing of fuels from fast reactors, it was necessary to determine fission products in the presence of large amounts of plutonium, especially when low burn-up fuels were to be analyzed. From results of a testing program in which classical analytical methods originally developed for uranium fuels were used to determine fission products, it was shown that adequate decontamination from plutonium and americium was not achieved in a number of cases. New or modified methods were developed for Zr, Nb, Ru, Rh, Ce, Nd, and Pr. All procedures were designed to utilize sample aliquots containing as much as 50 mg of plutonium and to give α-decontamination factors of not less than 10^5 and as high as 10^9, when from 10 to 50 mg of carrier were added. Ion-exchange methods proved to be the most effective for removing plutonium and americium in those cases where these elements caused interference. Methods for 14 fission products were tested or devised for use in the analysis of plutonium fuels. (auth)

8758 CONCENTRATION OF RADIOACTIVITY AND DETECTION OF COBALT-60 AND ZINC-65 IN RAINOUT. H. L. Kriger, J. E. Gilchrist, and S. Gold (Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio). Talanta, 6: 254-64(1960).

Ion-exchange resins were used to concentrate, isolate, and determine low levels of radioactive contaminants in rainwater. After the particulate and associated activities were removed by filtration, the ionic materials were retained on cation- and anion-exchange resin columns which are arranged in series. Consequently, a large volume can be passed through the resin columns before the exchange capacity is approached. Gamma scintillometry was used to identify the γ-emitters in each of the components in this concentration study. In addition to the expected fission-product activities in rainout, photopeaks attributed to Co^{60}

and Zn^{65} were discernible. Despite the fact that the activity levels of these nuclides were very low, their photopeaks were considered to be significant. However, for positive identification, quantitative separation was required. A sequential elution scheme based on the anionic adsorption of cobalt and zinc in solutions containing HCl in high concentration was used to separate the cobalt from the zinc, and from other anions adsorbed on the Dowex-1-(Cl) resin. Following elution, each nuclide was radiochemically isolated for quantitative measurement. (auth)

8759 DETERMINATION OF THE DISTRIBUTION OF FISSION Xe IN IRRADIATED UO_2 FUEL ELEMENTS. W. W. Morgan, R. G. Hart, F. C. Miller, and W. J. Olmstead (Atomic Energy of Canada Ltd., Chalk River Project, Ont.). Talanta, 6: 275(1960).

In the development of UO_2 fuel elements for power reactors, one of the important aspects to be considered is the physical behavior of the fission gas. The engineering concern is mainly that of pressure build-up inside the sheath, due to the release of fission gas from the oxide. Two analytical methods in use at Chalk River have contributed considerably to the investigation of the fate of the fission gas in experimental fuel elements: measurement of xenon released on puncturing the sheath of the fuel element and measurement of the radial distribution of xenon remaining in the UO_2. These two methods are described. (auth)

8760 INVESTIGATIONS CONCERNING EMISSION SPECTRUM ANALYSIS (III). SPECTROGRAPHIC ANALYSIS OF HAFNIUM IN ZIRCONIUM OXIDE. (I) Investigation on D. C. Arc Excitation. Shoushiro Sakai. Tokyo Kôgyô Shikensho Hôkoku, 55: 62-9(Feb. 1960). (In Japanese)

Preliminary work on the determination of hafnium in zirconium oxide used as reactor material is reported. The main difficulties in spectrochemical analysis of ZrO_2 for hafnium arise from two factors: the unstable volatilization of ZrO_2 and the indistinctness of hafnium spectral lines because of heavy background. Direct-current arc excitation using a relatively large current that consumes a fair amount of sample caused a heavy background owing to successive radiation from solid particles. The intensity of hafnium ion lines was decreased by the lowering of the arc temperature effected by low ionization potential of zirconium. Various spectrographic techniques of stabilizing the volatilization and suppressing the background were examined. Spectroscopic buffer did not sufficiently suppress the background; introduction of alkali or alkali earth elements seemed to depress the intensity of hafnium lines. Excitation in different atmospheres such as oxygen, argon, and their mixture was found to be of no advantage in the determination of hafnium in zirconium oxide. (auth)

8761 DETERMINATION OF MICRO-IMPURITIES IN HIGH-PURITY ANTIMONY BY RADIOACTIVATION ANALYSIS. E. E. Rakovskii, L. A. Smakhtin, and Yu. V. Yakovlev (V. I. Vernadskii Institute of Geochemistry and Analytical Chemistry of the USSR Academy of Sciences). Zavodskaya Lab., 26: 1199-1200(Nov. 1960). (In Russian)

A method was developed for determining the impurities still present in semiconductor grade antimony, prepared by zone melting, based on comparison of the activated materials in the unknown with similar ones in a reference standard. After ascertaining the chemical purity of the unknown sample, it is subjected, together with the reference material, to activation in a reactor flux of 8.7×10^{12} neutrons/cm^2/sec for periods ranging from 24 to 48 hr. The impurities present in the 100 mg of the samples ranged from 10^{-5} to 10^{-8} g. A method was developed for separating the individual elements by sorption on resin beds, elution, and chemical separation. After counting the individual activities, the concentrations were calculated from the corresponding values of the known reference sample. The following concentrations of the impurity elements have been determined with good reproducibility: 3×10^{-6}% Mn, 3.5×10^{-8}% Cu, $\leq 8 \times 10^{-7}$% Zn, 4×10^{-5}% As, $\leq 8 \times 10^{-6}$% P, $\leq 5 \times 10^{-4}$ Cr, and $\leq 3 \times 10^{-7}$% Ga. The results showed that radiochemically pure materials may be prepared by the purification method used. (TTT)

8762 METHOD FOR DETERMINING POTASSIUM BY ITS NATURAL RADIOACTIVITY. N. I. Pavlova and T. M. Khrenkova. Zavodskaya Lab., 26: 1201-2(Nov. 1960). (In Russian)

A new method was developed to increase the scope and efficiency and to reduce the time required for determining potassium on the basis of its natural radioactivity by improving the currently used techniques. The experimental setup consisted of a cylinder with a diameter of 100 mm and a height of 110 mm, surrounded by 8 counters, with one counter in the middle. The container was placed in a shielded housing to reduce the background. Thus a 0.5 mm thick layer of the liquid surrounded the counters; under these conditions the activity was proportional to the potassium concentration. Pure recrystallized potassium salts were used as reference standards. To reduce the relatively large amount needed for filling the container, the potassium salt can be diluted with NaCl, taking into consideration the resulting activity change. Potassium concentrations from 0.05% on could be easily determined, requiring about 2 min for the 50% and 3 hr for the 0.05% concentration range at a statistical error level of 1%. (TTT)

8763 DETERMINATION OF ZIRCONIUM IN NIOBIUM ALLOYS. Yu. A. Chernikhov and V. M. Vladimirova (State Scientific Research Institute of the Rare Metal Industry). Zavodskaya Lab., 26: 1207-8(Nov. 1960). (In Russian)

The usual complexometric titration of zirconium cannot be carried out in the presence of niobium because the tartric acid, which must be added to prevent the hydrolysis of the latter element, interferes with the titration. Therefore an amperometric method was developed for determining the zirconium by back titrating the excess of complexone$^{(+)}$ with a 0.01M bismuth salt solution, using dropping mercury as indicator electrode and a saturated calomel electrode as reference, at a pH = 2. Tests with synthetic mixtures indicated that good results can be obtained even with a 20 to 30 fold excess of niobium in the solution; even the presence of molybdenum and of tungsten can be tolerated. Up to 3% the zirconium may be determined directly; at lower concentrations the niobium must first be removed from the system. (TTT)

8764 COLORIMETRIC DETERMINATION OF THORIUM WITH ARSENAZO III IN PRODUCTS CONTAINING NIOBIUM. V. M. Vladimirova and N. K. Davidovich (State Scientific Research Institute of the Rare Metal Industry). Zavodskaya Lab., 26: 1210-12(Nov. 1960). (In Russian)

Previous methods used for determining small amounts of thorium in materials containing large amounts of niobium involved its separation as fluoride or oxalate. The reagent "arsenazo III" forms stable colored compounds with uranium and thorium, forming internal complexes which can be used for colorimetric determinations in the presence of fluorides, sulfates, etc., in highly acid solutions. The disturbing titanium and zirconium ions can be removed by adding a complexing agent to the solution. In a 3N HCl solution, in the presence of oxalic acid or of am-

monium oxalate, niobium did not interfere with the determination. A precision of 0.01% of thorium may be reached by the method. (TTT)

8765 DETERMINATION OF THE PHASES OF NITRIDED-LOW ALLOY, NIOBIUM CONTAINING STEELS. Yu. A. Klyachko, M. M. Shapiro, and E. F. Yakovleva (I. P. Bardin Central Scientific Research Institute of Ferrous Metallurgy). Zavodskaya Lab., 26: 1219-23(Nov. 1960). (In Russian)

As the effect of niobium in steels is due mostly to its distribution between the phases, phase analysis is of great importance. Up to now, however, even the binary systems Nb-C and Nb-N are only slightly known. Therefore phase studies were undertaken on several low-carbon steels. The specimens were electrolytically dissolved in an HCl–tartaric acid solution; for comparison, similar tests were made with a nonaqueous electrolyte of HCl–methylalcohol. In both cases identical results were obtained by chemical analysis and x ray diffraction of the anodic deposit: the single cubic phase had a lattice constant of 4.428 to 4.435, corresponding to niobium carbonitride. The characteristic hexagonal structure of niobium nitride was not revealed by x ray diffraction. Pure niobium carbide was formed in vacuum treatment. The composition of the phase in low-nitrogen steels was about Nb $(C,N)_{1.06}$; in high nitrogen (about 0.07%) steels it was close to Nb $(C,N)_{1.10}$. (TTT)

8766 DETERMINATION OF INDIUM CONTENT IN SPHALERITES BY RADIOACTIVATION ANALYSIS. A. A. Abdullaev, E. M. Lobanov, A. P. Novikov, M. M. Romanov, and A. A. Khaidarov (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Zhur. Anal. Khim., 15: 701-5(Nov.-Dec. 1960). (In Russian)

A method for the determination of indium content in sphalerites based on the measurement of the γ-ray spectrum intensity of the activated samples in a scintillation γ spectrometer is described. Indium can be determined in the range of concentrations from 0.1 to 0.01%. The possible experimental error is 5 to 10%. There is no necessity for radiochemical treatment of the samples. (auth)

8767 ANALYTICAL APPLICATIONS OF THERMOGRAVIMETRY. II. THERMOGRAVIMETRIC STUDY OF PLUTONIUM COMPOUNDS. I. S. Skiyarenko and T. M. Chubukova (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, Moscow). Zhur. Anal. Khim., 15: 706-10(Nov.-Dec. 1960). (In Russian)

The possibility of using $Pu(SO_4)_2$ as a gravimetric standard formed either from plutonium sulfate tetrahydrate or from anhydrous plutonium sulfate is discussed. When plutonium iodate is used in gravimetric analysis, the precipitate should be thoroughly washed to remove the precipitant excess, then it may be dried at 200°. The possibility of using anhydrous Pu^6 oxalate for gravimetric determinations is shown. In this case, it is necessary to dry plutonium oxalate hexahydrate at 140 to 150°. Plutonium 8-hydroxyquinolinate, on heating at 230° (but not exceeding 250°) corresponds to the formula $Pu(C_9H_6NO)_4$ and can be used as a gravimetric standard. (auth)

8768 QUANTITATIVE SPECTROGRAPHIC DETERMINATION OF ADMIXTURES OF RARE EARTHS. Yu. I. Belyaev and L. A. Krivonos (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zhur. Anal. Khim., 15: 711-15(Nov.-Dec. 1960). (In Russian)

A method was developed for the quantitative spectrographic determination of small amounts of admixtures of La in Pr; Sm, Pr, and Eu in Nd; Sm and Yb in Eu; Eu and Tb in Gd; Y, Dy, and Gd in Tb; Y in Dy; Er and Dy in Ho; Ho and Tu in Er; Tu in Yb; Dy in Y; Tb in Y; Yb and Tu in Lu; and Yb in Tu. (auth)

8769 X-RAY SPECTRAL ANALYSES (REVIEW). E. E. Vaĭnshteĭn (Inst. of Inorganic Chemistry, U.S.S.R.). Zhur. Strukt. Khim., 1: 360-9(Sept.-Oct. 1960). (In Russian)

A survey is given of the techniques, equipment, and theory of x-ray spectral analysis. Perspectives, trends, and new methods are discussed. 111 references. (R.J.V.)

8770 L'ANALYSE SÉLECTIVE DU ZINC ET DU COBALT PAR DOUBLE MARQUAGE RADIOACTIF ET SPECTROMÉTRIE DU RAYONNEMENT GAMMA. (Selective Analysis of Zinc and Cobalt with Double Radioactive Tagging and a Gamma Spectrometer). Robert Collée. Monographie No. 8. Brussels, Institut Interuniversitaire des Sciences Nucléaires, 1959. 60p.

A study was made of a method of γ spectrometric analysis in the case of simultaneous labeling of several metallic elements. Certain difficulties were encountered in the characteristics of the apparatus used. In particular the sensitivity and precision are limited by the physical and statistical properties of the channels and by other phenomena such as the existence of a continuous background and imperfections in the electronic stability. Also the reputedly characteristic energies were not absolutely specific for the elements studied; so it was necessary in each case to select judiciously the most appropriate statistical surface. The experimental results obtained show that simultaneous quantitative analysis of zinc and cobalt in very small samples is sufficiently precise for weights greater than a millionth of a gram. The application of the method to smaller quantities, of the order of billionths of a gram, seems to be limited by the capabilities of the apparatus but can be used to obtain very valuable estimates in various scientific studies. (tr-auth)

General Inorganic and Physical Chemistry

8771 (AFOSR-60-177) STUDY OF SOLID VAPOR EQUILIBRIA IN THE RARE EARTH–RARE EARTH METAL SYSTEMS. David White (Ohio State Univ. Research Foundation, Columbus). Oct. 1960. 11p. Contract AF-18(600)-1545, Project No. 77520.

The rates of vaporization of 17 rare earth-rare earth metal systems were measured by the Knudsen effusion technique. The thermodynamics of vaporization reactions were determined. Some preliminary theoretical work was done in order to account for both the observed decrease in dissociation energy with atomic number and the double periodicity of this decrease. (W.L.H.)

8772 (CF-59-6-132) URANIUM ANION EXCHANGE EQUILIBRIA ON DOWEX 21K. W. E. Dunn (Oak Ridge National Lab., Tenn.). June 29, 1959. 8p.

Equilibrium loading of uranium on Dowex 21K was studied in a sulfate system for uranium concentrations from 0.0005 to 0.005M, total sulfate concentrations of 0.045 to 0.6M, and sulfuric acid concentration of 0.020M. Loading data were fitted to Langmuir adsorption isotherms and Langmuir constants were evaluated. Resin was equilibrated with uranium feed solutions by flowing the feed through a shallow fixed bed of resin. (auth)

8773 (CF-59-9-65) SOLUBILITY OF OXYGEN IN AQUEOUS URANYL SULFATE SOLUTIONS AT ELEVATED

TEMPERATURES AND PRESSURES. R. J. Davis (Oak Ridge National Lab., Tenn.). Sept. 17, 1959. 13p.

Plots of oxygen solubility data are presented. The plots involve interpolation and extrapolation of those data to cover a temperature range of 210 to 330°C, an oxygen pressure range of 0 to 2000 psi, and a uranyl sulfate concentration range of 0 to 300 g of uranium per liter. (auth)

8774 (CF-59-10-121) THE CONCENTRATION OF PEROXIDE IN URANYL SULFATE SOLUTIONS AT INCIPIENT PRECIPITATION. L. O. Gilpatrick, H. R. Jolley, M. J. Kelly, M. D. Silverman, and G. M. Watson (Oak Ridge National Lab., Tenn.). Oct. 22, 1959. 17p.

The concentrations of peroxide in uranyl sulfate solutions at incipient precipitation of uranium peroxide were determined at 79 to 114°C. The results of the experimental observations were used to calculate a self-consistent set of numerical parameters that are related to the equilibrium of hydrogen peroxide, uranyl ions, and hydrogen ions. The observed concentrations of peroxide at saturation were found to follow the relation: $P_{(sat)} = [1.0 + 360(H^+)^2/(UO_2^{++})] \times 10^{-4}$M, in terms of the stoichiometric acid and uranyl ion concentrations investigated. (auth)

8775 (CF-59-12-31) REACTIONS BETWEEN NITRIC ACID AND ORGANIC COMPOUNDS. A REVIEW. W. H. Baldwin and C. E. Higgins (Oak Ridge National Lab., Tenn.). Dec. 10, 1959. 10p.

Nitric acid and nitrates react with organic compounds as an oxidizing agent, ranging from controlled syntheses to the self-sustaining reactions of rocket fuels and gunpowder. Nitric acid and nitrates may react to form nitrate esters or nitro compounds. The reactions are usually exothermic, and the products are often thermodynamically unstable. Oxidation and nitration reactions usually occur simultaneously. Self-sustaining reactions were found in solutions, as well as in the dry state. (auth)

8776 (CF-59-12-38) CALCULATION OF THE DIFFUSION COEFFICIENT OF PERTECHNETATE AND PERRHENATE IONS FROM CONDUCTIVITY MEASUREMENTS. P. F. Thomason (Oak Ridge National Lab., Tenn.). Dec. 9, 1959. 5p.

During the polarographic studies of technetium it became necessary to determine the diffusion coefficient of TcO_4^- ion. In order to calculate the number of electrons involved in the polarographic reduction process by means of the Ilkovic equation ($id = 607nD^{1/2} Cm^{2/3} t^{1/6}$), the diffusion coefficient (D) must be known. Specific conductance measurements of $KReO_4$ and $KTcO_4$ solutions were made. From these data the diffusion coefficients of ReO_4^- and TcO_4^- ions were calculated. (auth)

8777 (CF-59-12-95) CHEMISTRY OF Pu(IV) POLYMER. R. H. Rainey (Oak Ridge National Lab., Tenn.). Dec. 30, 1959. 4p.

Pu(IV) polymers may form in solutions containing as much as 0.3M acid at room temperature. At higher temperatures, polymers may be formed at even higher acidities. Dilution of plutonium solutions with water can result in polymer formation, caused by local dilution of the acid, even when the final equilibrated solution would be stable. The polymer may be destroyed in acid solutions by oxidation or reduction of the plutonium or by the use of complexing agents. (auth)

8778 (NP-9712) SPECIFIC SURFACE DETERMINATION OF URANIUM OXIDE POWDERS BY DYE ADSORPTION. Alois Langer (Westinghouse Electric Corp. Research Labs., Pittsburgh). September 21, 1956. 27p. (100FF1009-R1)

In an investigation of uranium oxide surface determination methods, thionine blue was found to have the greatest adsorption, and for solvents, water solutions seem to be the best. The amount of dye present in the solution has to be at least five times the amount being adsorbed and the time of shaking to reach saturation at least 12 hr. The temperature of the solution should be kept constant and the chemical composition of the precipitate must be the same. By following these instructions, a linear relationship between the specific surface determined by gas adsorption and dye adsorption seems to exist. (auth)

8779 (OOR-2099:2) THE ENERGY LEVELS OF Pr^{+++} IN $PrCl_3$. Technical Report No. 1. Jack Selig Margolis (California. Univ., Los Angeles). June 1960. 149p. Contract DA-04-495-ORD-1375.

The availability of a large amount of empirical data has provided the means for a rather thorough test of the validity of the usual application of crystalline field theory to the computation of the energies of the levels. Some important results of this study are a set of more accurate parameter values useful in other type of calculations and the prediction of the location of heretofore undiscovered levels. (auth)

8780 (ORNL-2955) ADSORPTION OF XENON AND ARGON ON GRAPHITE. M. C. Cannon, W. T. Ward, G. M. Watson, and W. R. Grimes (Oak Ridge National Lab., Tenn.). Dec. 12, 1960. 23p. Contract W-7405-eng-26.

Adsorption isotherms for xenon on AGOT-grade graphite, having a surface area of 0.64 m^2/g, were determined at −79, 0, 20, 30, and 80°C in order to determine whether the presence of helium affects the adsorption behavior of xenon. The isotherms obtained from xenon-helium mixtures were essentially the same as those obtained using pure xenon gas. The calculated heats of adsorption for xenon range between 3500 and 3700 cal/mole and approximate the heat of vaporization of 3270 cal/mole reported in the literature. The volume of xenon adsorbed (cm^3 at STP) per gram of graphite, a, vs. xenon partial pressure, P (mm Hg), may be expressed by the equation $a = bp^{0.8}$. The values of b are 2.14×10^{-4} and 6.33×10^{-5} at 0 and 80°C, respectively. Extrapolation of the measurements to higher temperatures gives values of b of 6.5×10^{-6} and 4.1×10^{-6} at 500 and 750°C, respectively. Adsorption isotherms for argon were determined at −83 and 0°C and can be expressed by the same equation indicated above. At −83 and at 0°C, b has values of 1.00×10^{-4} and 1.60×10^{-5}, respectively. (auth)

8781 (ORNL-2982) SELF-DIFFUSION OF CHROMIUM IN NICKEL-BASE ALLOYS. R. B. Evans, III., J. H. DeVan, and G. M. Watson (Oak Ridge National Lab., Tenn.). Feb. 8, 1961. 41p. Contract W-7405-eng-26.

The self-diffusion coefficients of Cr^{51} in Inconel and INOR-8, were measured by contacting the alloys with fused salt mixtures containing radioactive chromous fluoride. The experiments were designed to provide data at 600 to 900°C, where relatively low diffusion coefficients (10^{-10} to 10^{-12} cm^2/sec) were obtained. Results indicate that at lower temperatures, diffusion occurs largely through selective paths, whereas at high temperatures, homogeneous diffusion occurs. The observed diffusion coefficients can be expressed by the equation $D = D_0 e^{-E/RT}$. The values of D_0 and E were found to vary, depending on the history of the specimen. For Inconel specimens annealed at 1150°C for periods of 2 hr or longer, the values of E ranged from 62 to 66 kcal/mole, and the values D_0 from 1.0 to 2.8 cm^2/sec. For the two alloys studied the observed diffusion coefficients were the same. (auth)

8782 (ORNL-3003) PREPARATION OF AMERICIUM DIOXIDE BY THERMAL DECOMPOSITION OF AMERICIUM OXALATE IN AIR. R. D. Baybarz (Oak Ridge National Lab., Tenn.). Dec. 20, 1960. 11p. Contract W-7405-eng-26.

One hundred and seventy five grams of americium in a hydrochloric acid solution varying from 1 to 7 N was converted to americium dioxide. Americium oxalate was precipitated from 0.1 N HCl with 100% excess oxalic acid and was converted to the dioxide by calcination at 800°C in air. The solubility losses in the oxalate precipitation filtrate averaged approximately 7 mg/liter of solution, with a total loss of 0.09%. (auth)

8783 (TID-6851) REACTIONS IN NON-AQUEOUS SOLVENTS. Progress Report [for] July 25, 1959 to September 30, 1960. Helmut M. Haendler (New Hampshire. Univ., Durham). Oct. 15, 1960. 16p. Contract AT(30-1)-1964.

A preliminary investigation of the bromination of uranium in methanol indicates that hydrogen bromide and/or hypobromous acid, as well as bromine, are involved in the oxidation. A series of reactions was postulated. The synthesis, from methanol solution, of the complexes $(NH_4)_3NbOF_6$, $(NH_4)_3UO_2F_5$, $(NH_4)_3VOF_5$, $(NH_4)_3TaF_8$, K_3NbOF_6, K_3VOF_5, K_3TaOF_6, and $K_3UO_2F_5$ is reported. A group of 25 metal halide complexes with phenanthrenequinone and chrysenequinone was prepared by reaction in nonaqueous solutions. Some infrared and x-ray data were obtained. (auth)

8784 (TID-11646) FINAL REPORT ON [MEASUREMENT OF HEAT CAPACITY]. [(Chicago. Univ.)]. [1960]. 6p. Contract AT(11-1)-280.

The heat capacities (C_p), entropies (S^0), $[(H^0 - H_0^0)/T]$, and $-(F^0 - H^0)/T$ are calculated and tabulated for l-cystine, l-tyrosine, l-asparagine hydrate, and glycyl glycine at temperatures from 11 to 310°K. (B.O.G.)

8785 (AEC-tr-3976) THE CHAIN MECHANISM OF THE DECOMPOSITION OF HALOGENATED PARAFFINS. (Mekhanizm tsepnogo raspada galoidoproizvodnykh parafinov). N. N. Semenov. Translated from Uspekhi Khim., 21: 641-713(1952). 115p. (PST-Cat. No. 77).

The chain theory is represented as a method for treating experimental material of the group of decomposition reactions of halogenated paraffins. The cracking, oxidation, and polymerization chain reactions studied are of interest from the theoretical as well as the practical aspect. A review of the literature on the decomposition of halogenated paraffins resulted in an eclectic point of view which is concluded to be unjustified from the experimental and theoretical points of view. Results of the application of the chain theory to these reactions are described. 89 references. (B.O.G.)

8786 (AEC-tr-4051) JOURNAL OF INORGANIC CHEMISTRY. Translation of Zhurnal Neorganicheskoi Khimii, II: No. 1, 1957. 365p. (PST-Cat. No. 78).

8787 (AEC-tr-4051(p.1-8)) COMPOSITION AND DISSOCIATION PRESSURE OF A STABLE CRYSTALLOHYDRATE OF URANIUM TETRAFLUORIDE. M. M. Popov and Yu. V. Gagarinskii. Translated from Zhur. Neorg. Khim., 2: No. 1, 3-8(1957).

An investigation to determine the composition of stable UF_4 crystallohydrates and to measure their dissociation pressure was conducted. The existance of the stable crystallohydrate $UF_4 \cdot 2 \cdot 5H_2O$ was established with a dissociation pressure at 20 to 35°C, represented by $\log_p = 10.035 \pm 0.003(2920 \pm 3/T)$. The calculated heat of hydration of UF_4 by liquid water is 7.23 kcal/mole of the salt. (J.R.D.)

8788 (AEC-tr-4051(p.31-42)) THE CHEMISTRY OF COMPOUNDS OF A VARIABLE COMPOSITION. S. M. Ariya, E. M. Kolbina, and M. S. Apurina. Translated from Zhur. Neorg. Khim., 2: No. 1, 23-9(1957).

The extent of the homogeneity region of cobalt tellurides was investigated. It was found that at 900°C, the lower limit of the homogeneity region for cobalt telluride lies close to the composition $CoTe_{1.2}$, whereas in preparations cooled to room temperature this limit lies close to the composition $CoTe_{1.45}$. The upper limit lies at the composition of $CoTe_{1.9}$ or extends somewhat further into a region of higher tellurium contents. The compound of the composition $CoTe_{1.33}$ (Co_3Te_4) probably exists at low temperatures, and a compound $CoTe_{1.2}$ (Co_5Te_6) is also indicated by heat of formation data. Within the limits of the homogeneity region, the enthalpy of the formation of tellurides is shown as linear functions of the composition. At the same time, the enthalpy of formation corresponding to compositions that are within the limits of the homogeneity region, does not differ in practice from the enthalpy of formation of $CoTe_{1.2}$ and $CoTe_{2.0}$ of the same gross composition. Data indicated that in cobalt ditelluride ($CoTe_2$), cobalt is tetravalent. (J.R.D.)

8789 (AEC-tr-4051(p.196-213)) THE SALICYLATES OF URANIUM AND THORIUM. O. E. Zvyagintsev and B. N. Sudarikov. Translated from Zhur. Neorg. Khim., 2: No. 1, 128-37(1957).

This paper was previously abstracted from a French translation and appears in NSA, Vol. 13, Abstract No. 8787.

8790 (AEC-tr-4051(p.276-95)) FUSION DIAGRAM OF THE RECIPROCAL SYSTEM OF THE FLUORIDES AND SILICATES OF LITHIUM AND POTASSIUM. A. G. Bergman and N. A. Bychkova-Shul'ga. Translated from Zhur. Neorg. Khim., 2: No. 1, 179-92(1957).

Results of studies of systems involving lithium fluoride, lithium silicate, potassium fluoride, and potassium silicate are presented. The investigations were carried out by the visual-polythermic method. Tabulated data and constitution diagrams on the systems, $K_2SiO_3-Li_2SiO_3$, $K_2SiO_3-K_2F_2$, $Li_2F_2-Li_2SiO_3$, and $Li_2F_2-K_2F_2$ are included. (J.R.D.)

8791 (AEC-tr-4051(p.319-24)) CONDITIONS OF FORMATION OF SOLID SOLUTIONS IN THE SYSTEM CeO_2-SrO. E. K. Keler and N. A. Godina. Translated from Zhur. Neorg, Khim., 2: No. 1, 209-11(1957).

Results of a study of CeO_2-SrO solid solutions by x-ray, chemical-phase, and thermic analyses are presented. Results indicate that strontium cerate is an intermediate in the formation of the solid solution in this system. (J.R.D.)

8792 (AEC-tr-4051(p.339-47)) STUDY OF SOLUBILITY IN THE SYSTEM $UO_2C_2O_4-H_2C_2O_4-H_2O$. K. A. Bol'shakov, S. S. Korovin, V. E. Plyushchev, and T. A. Ermakova. Translated from Zhur. Neorg. Khim., 2: No. 1, 222-8(1957).

Results of a study to determine the effects of oxalic acid on the solubility of uranyl oxalate in water at 0, 25, 40, 50, and 70°C are presented. The solubility of uranyl oxalate increases in the presence of up to 13 wt.% of oxalic acid. The solid phases of the system are $ClO_2C_2O_4 \cdot 3H_2O$ and $H_2C_2O_4 \cdot H_2O$. (J.R.D.)

8793 (AEC-tr-4344) SPECTROSCOPIC INVESTIGATION OF VAPOROUS GALLIUM HALIDES. With An Addendum Pertaining to Gallium Oxide Spectrum. E. Miescher and M. Wehrli. Translated by Lydia Venters (Argonne National Lab.) from Helv. Phys. Acta, 7: 331-59(1934). 30p.

Results of a spectroscopic investigation of gallium halide vapors and gallium oxide are given. Data are tabulated. (J.R.D.)

8794 (AEC-tr-4347) THERMAL ANALYSIS OF SYSTEMS $AlCl_3$–NaCl AND $AlCl_3$–KCl. U. I. Shvartsman. Translated by Lydia Venters (Argonne National Lab., Ill.) from Zhur. Fiz. Khim., 14: 253-6(1940). 5p.

The results of thermal analysis of the systems $AlCl_3$-NaCl and $AlCl_3$-KCl are presented and discussed. The state diagrams are included and compared with data from the literature. (T.R.H.)

8795 (AEC-tr-4355) BORON MONOXIDE. E. Zintl, W. Morawietz, and E. Gastinger. Translated for Oak Ridge National Laboratory by The Technical Library Research Service from Z. anorg. u. allgem. Chem., 245: 8-11(1940). 6p.

A study was made to determine the existence of boron monoxide. Purified boron was distilled with ZrO_2, and the products obtained were weighed. Analysis of the results indicates that boron monoxide was formed. (T.R.H.)

8796 (AEC-tr-4356) SPECTROSCOPIC INVESTIGATION OF INDIUM HALIDE VAPOR. M. Wehrli and E. Miescher. Translated by Lydia Venters (Argonne National Lab., Ill.) from Helv. Phys. Acta., 7: 298-330(1934). 34p.

The emission and absorption spectra of vapors of InCl, InBr, and InI were studied using a quartz spectrograph and a 3-m grid (second order). Expanded spectra were found, and their oscillation analyses were carried out. (T.R.H.)

8797 (AEC-tr-4359) ELECTROCONDUCTIVITY OF ICE. N. V. Ril'. Translated by Lydia Venters (Argonne National Lab.) from Zhur. Fiz. Khim., 29: 1372-82(1955). November 1960.

The study of energy migration and charges in protein macromolecules is extended with a study of electric conductivity in ice. (T.R.H.)

8798 (NP-tr-543) ON MULTINUCLEAR CHLORIDES OF NIOBIUM AND TANTALUM. E. (Ye.) I. Krylov. Translated from Izvest. Vysshykh Ucheb. Zavedenii, Khim. i Khim. Tekhnol. No. 4, 676-9 (1958). 6p.

The magnetic susceptibility of multinuclear niobium and tantalum chlorides was investigated $[Me_6Cl_{12}]Cl_2 \cdot 7H_2O$, where Me = Nb or Ta. It was established that in the temperature range 78 to 293°C the susceptibility of these compounds obey the Curie-Weiss law with negative values of the θ constant. It is shown that the composition of molecules of multinuclear niobium and tantalum chlorides includes: two positive paramagnetic Nb^+ or Ta^+ ions and four diamagnetic niobium or tantalum atoms. (W.L.H.)

8799 (NP-tr-552) ON THE ARTICLE BY S. V. GORBACHEV AND E. Ya. MINDOVICH "DISTRIBUTION OF PICRIC ACID I AND II." F. S. Kulikov. Translated by V. Beak (U.K.A.E.A. Atomic Energy Research Establishment) from Zhur. Fiz. Khim., 23: 2232-3(1954). 7p.

A review of a formulation on the distribution of substances between two phases is presented. The interpretation of data on the distribution of picric acid between water and nitrobenzene at 20, 40, 60, and 80°C by other workers is critically discussed. (J.R.D.)

8800 ON THE COMPLEX CHEMISTRY OF THE TERVALENT RARE-EARTH IONS. V. THE ACETATE AND GLYCOLATE SYSTEMS OF YTTRIUM. Artur Sonesson (Univ. of Lund, Sweden). Acta Chem. Scand., 14: 1495-8 (1960). (In English)

The complex formation of the yttrium acetate system and the yttrium glycolate system was studied potentiometrically. The measurements were performed at 20°C in a perchlorate medium of ionic strength 2.0M. It was found that both systems show significant similarities with the correspondent systems in the middle of the lanthanum series. The complexity constants of the yttrium acetate system are lower than the constants of the dysprosium system, but the ratios b_n/b_{n+1} between the consecutive stability constants coincide rather well for the two systems. The complexity constants of the yttrium glycolate system show a rather good agreement with the complexity constants of the gadolinium glycolate system. The values of the ratios b_n/b_{n+1} place the yttrium system between the samarium and the gadolinium systems. (auth)

8801 RAMAN SPECTRUM AND INFRARED SPECTRUM OF DEUTERATED VINYL CHLORIDES. M. de Hemptinne, G. Germain-Lefevre, R. Van Riet, and D. Lenaerts (Univ., Louvain). Bull. classe sci., Acad roy. Belg., 46: 310-35(1960). (In French)

The Raman vibration spectrum of the molecules CHD = CHCl, CHD = CDCl, and CD_2 = CDCl in the liquid phase was photographed by means of a prism spectrograph using the Hg 4358 A line as the exciting beam. The infrared spectrum of the molecules CHD = CHCl and CHD = CDCl in the liquid phase was recorded from 400 to 3200 cm^{-1} with a prism spectrometer. The diffusion and adsorption rays observed were attributed to the self-vibrations of these molecules. The attributions were controlled by the Teller-Redlich rule and the sum rule. Two different preparations of the products permit the separation of the self-vibrations of the "cis" and "trans" forms of the molecules CHD = CHCl and CHD = CDCl. (tr-auth)

8802 PREPARATION AND PROPERTIES OF THE URANYLTRICARBONATES OF CALCIUM AND MAGNESIUM. André Chambionnat. Compt. rend., 251: 2377-9 (Nov. 21, 1960). (In French)

Several methods for the preparation of the uranyltricarbonates of calcium and magnesium were perfected. The hydrates $Ca_2[UO_2(CO_3)_3] \cdot 4H_2O$ and $Mg_2[UO_2(CO_3)_3] \cdot 2OH_2O$ were obtained and their solubilities in water were determined. It appears possible to effect, with the aid of these compounds, a separation of uranium from natural calcium phosphates. (tr-auth)

8803 THE PREPARATION OF RHENIUM BY FLUORINATION OF THE METAL WITH CHLORINE TRIFLUORIDE. N. S. Nikolaev and E. G. Ippolitov. Doklady Akad. Nauk, S.S.S.R., 134: 358-9(Sept. 11, 1960). (In Russian)

Fluorination of rhenium metal was carried out at 300°C with the use of ClF_3 as the fluorinating agent in order to avoid the formation of rhenium oxyfluorides which are obtained by direct fluorination with fluorine gas. ReF_6, with an excess of ClF_3, was collected in a receiver and crystallized from anhydrous HF in the form of large light-yellow crystals of the solvate $ReF_6 \cdot xClF_3$. Pure ReF_6 was obtained by distillation in a current of hydrogen at 50°C in a platinum tube and by holding in a vacuum at −70°C for 4 hr to eliminate traces of Cl_2 and HF. The melting point of the product ReF_6 was found to be 18.7 ± 0.1°C. The analyses of the product showed 62.4% Re and 38.2% F compared with theoretical values of 62.04% Re and 37.96% F for ReF_6. Chlorine could not be found in the product. (TTT)

8804 THE FORMATION OF TANTALUM IODIDES AND IODIDE TANTALUM. D. M. Chizhikov and B. N. Rabinovich. Doklady Akad. Nauk, S.S.S.R., 134: 368-70 (Sept. 11, 1960). (In Russian)

A mixture of purified tantalum and iodine was heated in a sealed quartz ampoule with walls 3 mm thick. A vigorous exothermic reaction was observed to start at 370°C and to end at 535°C. The iodide formed corresponds to the for-

mula $TaI_{2.8-3.0}$. The character and type of deposit obtained by the thermal dissociation of tantalum iodides on heated wires (0.7-mm-diameter) were investigated. The tantalum metal was found to contain almost no gaseous or metallic impurities. It was plastic and could be pressed at room temperature. The microhardness of the tantalum metal perpendicular to the transverse cross section of the wire was 130 to 150 kg/mm² at a loading of 50 g. (TTT)

8805 THE FRANCK-CONDON PRINCIPLE AND THE IONIZATION AND DISSOCIATION OF HYDROGEN BY ELECTRON IMPACT. D. P. Stevenson (Shell Development Co., Emeryville, Calif.). J. Am. Chem. Soc., 82: 5961-6 (Dec. 5, 1960).

Various data on the ionization and dissociation of hydrogen and deuterium by single-electron impact are reviewed. It is shown that neither the average appearance potentials of H_2^+ and D_2^+ nor the distribution in kinetic energy of the protons or deuterons are those expected from the conventional application of the Franck-Condon principle to the potential-energy diagrams of hydrogen and its molecule ions. The experimental findings can be rationalized with the presumably accurately known potential-energy-curve information on the hypothesis that 15- to 100-volt electrons can form transient complexes with hydrogen molecules $[H_2^-]$, with lives in the range of 10^{-14} to 10^{-13} sec. (auth)

8806 THE MECHANISM OF ISOTOPE EXCHANGE OF HYDROGEN ON PLATINUM PELLICLES. G. K. Boreskov and A. A. Vasilevitch (Karpov Inst. of Physics and Chemistry, U.S.S.R.). Kinetika i Kataliz, Akad. Nauk S.S.S.R., Sbornik Statei, 1: 69-82(May-June 1960). (In Russian)

Deuterium and H^3 were used in studies of isotopic exchange in molecular hydrogen and in hydrogen adsorbed on platinum plates at 78 and 90°K. A heterogeneity in adsorption on platinum surfaces was found, and a coefficient for hydrogen isotope separation in adsorption was determined. The rate of molecular exchange was found by measuring the kinetic isotopic effects, and the possible mechanisms, of the process were determined. The use of H^3 improved the accuracy of both the exchange rate and the magnitudes of thermodynamic and kinetic effects. (R.V.J.)

8807 ISOTOPIC EXCHANGE OF HYDROGEN ON GERMANIUM SAMPLES OF THE n- AND p-TYPE. Yu. A. Shlyapnikov (Karpov Inst. of Physics and Chemistry, U.S.S.R.). Kinetika i Kataliz, Akad. Nauk S.S.S.R., Sbornik Statei, 1: 356-64(Sept.-Oct. 1960). (In Russian)

The rates of hydrogen exchange and adsorption were studied with n- and p-type germanium specimens. The rates were close for all specimens in spite of a wide variation (7 to 9) in the concentration of electrons and holes, indicating that electrons and holes do not participate in the reactions. The isotopic exchange of molecular hydrogen on a germanium surface follows an adsorption-desorption mechanism. (tr-auth)

8808 THE ISOTOPE EFFECT IN THE ELECTROLYTIC MIGRATION OF LEAD IONS IN MOLTEN LEAD BROMIDE. Arnold Lundén and Göran Blomqvist (Chalmers Technische Hochschule, Göteborg, Sweden). Z. Naturforsch. 15a, 950-2 (Nov. 1960). (In German)

By electrolytic transformation, the light lead isotopes were enriched at the boundary between molten LiBr and $PbBr_2$. The mass effect (relative difference of the migration velocity/relative difference of the masses) was shown to be $\mu = -0.041 \pm 0.006$, which confirmed that this value is smaller in lead halogenides than in other halogenides. (tr-auth)

8809 THE THEORY OF THE π-ELECTRON SYSTEM. Hermann Hartmann (Univ., Frankfurt, Germany). Z. Naturforsch. 15a, 993-1003 (Nov. 1960). (In German)

The second Hückel approximation was extended by consideration of the higher atomic states. The explanation for the Scheibe phenomenon is given. The concept of "theoretical probe energy (resonance energy)" is corrected. The known difficulties, which are found in the comparison of spectroscopic and caloric energy values in the scope of the single electron energy of a π-e system, disappear. (tr-auth)

8810 THE HEAT CONDUCTIVITY OF NORMAL AND PARA HYDROGEN AT 20°K Karl Heinzinger (Max-Planck Inst. für Chemie, Mainz, Germany). Z. Naturforsch. 15a, 1022 (Nov. 1960). (In German)

Because of the diverse results obtained in heat conductivity measurements on normal and para hydrogen at 20°K it appeared of interest to repeat the investigations. A differential method was used for the measurements. The heat conductivity ratio was determined to be $\lambda(p-H_2)/\lambda(n-H_2) = 1.0057 \pm 0.0007$. Measurements made at 20, 50, and 100 Torr gave the same results within the limits of error. (J.S.R.)

8811 THE CRYSTAL STRUCTURE OF SOLID DEUTERIUM–HYDROGEN. R. F. Bulatova, V. S. Kogan, and B. G. Lazarev. Zhur. Eksptl'. i Teoret. Fiz., 39: 1853 (Dec. 1960). (In Russian)

Gaseous deuterium–hydrogen, containing 50% HD, 25% H_2, and 25% D_2, was prepared by electrolysis of 50% heavy-water solution in ordinary water. A helium cryostat was used for determining the structure of solid HD. Only one line at 19° was observed. The lattice of HD belongs to the spatial group C_4^5. The density of solid DH calculated with the parameters a = 3.39 A, c = 5.86 A, and c/a = 1.73 is 0.146 g/cm³. With a constant value of c/a in deuterium–hydrogen, deuterium, and H^3, the lattice parameters diminish, a = 3.39, 3.35, and 3.30 A, respectively. (R.V.J.)

8812 SOLUBILITY OF SCANDIUM HYDROXIDE IN CAUSTIC SODA SOLUTION. B. N. Ivanov-Emin, L. A. Nisel'son, and A. T. Ivolgina. Zhur. Neorg. Khim., 5: 2841-2(Dec. 1960). (In Russian)

The solubility of $Sc(OH)_3$ in 1.0 to 19M NaOH was analyzed. The maximum solubility was 5.0 g/liter in 11.7 mole/liter NaOH. The solid phase up to maximum solubility is expressed by crystalline scandium hydroxide. At higher alkali concentrations the solid phase appears as $Na_3Sc(OH)_6$. (R.V.J.)

8813 ON EFFECTIVE ATOMIC CHARGES IN COMPLEX X RADIATION ABSORPTION SPECTRA. R. L. Barenskiĭ (Inst. of Rare Elements, Academy of Sciences, USSR). Zhur. Strukt. Khim., 1: 200-8(July-Aug. 1960). (In Russian)

A method is suggested for calculating x-ray K spectra for absorption in molecules and complexes with approximately central field symmetry in the vicinity of the absorbing atom. The atomic charge and its effective radius in the examined compound are evaluated. The method was used for calculating the atomic charge in complex transition metal compounds with various chemical bonds. It is shown that the bond is mostly covalent in aromatic metallic complexes except for $(C_5H_5)_2$ Mn which has ionic type bonds. (tr-auth)

8814 LITHIUM URANATE(V), $LiUO_3$. L. M. Kovba and A. N. Golubenko (Moscow State Univ., U.S.S.R.). Zhur. Strukt. Khim., 1: 390-2(Sept.-Oct. 1960). (In Russian)

In the thermal dissociation of lithium monouranate,

α-Li_2UO_4, the initial product is $LiUO_3$, followed by $(Li,U)O_{2\pm x}$. Lithium uranate (V) has a distorted perovskite type structure (rhombohedron) with lattice parameters (hexagonal) a = 5.406 ± 0.001 kX and c = 7.506 ± 0.004 kX. The $(LiU)O_{2\pm x}$ has a fluorite type structure, similar to uranium dioxide and other mixed oxides $(Me,U)O_{2\pm x}$. (R.V.J.)

Radiation Chemistry and Radiochemistry

8815 (ARF-1165-2) RADIATION SYNTHESIS INVOLVING HALOGENATED COMPOUNDS. Progress Report No. 2 (Covering the Period from May 1, 1960 to July 31, 1960). K. E. Schmude, W. A. Glasson, and P. Y. Feng (Illinois Inst. of Tech., Chicago. Armour Research Foundation). July 31, 1960. 11p.

Study continued on the mechanism of radiation-induced synthesis in selected two-component systems containing toluene plus a halogenated compound. Heated irradiation devices were designed, constructed, and operated for the gas-phase toluence halogenation experiments. Samples containing toluence and CF_4, SiF_4, SF_6, or CCl_4 were prepared and irradiated. Chromatography and infrared spectroscopy of the products were investigated. (W.L.H.)

8816 (ARF-1165-5) RADIATION SYNTHESIS INVOLVING HALOGENATED COMPOUNDS. Progress Report No. 2 (covering the period from August 1, 1960 to October 31, 1960). W. A. Glasson, P. Y. Feng, and K. E. Schmude (Illinois Inst. of Tech., Chicago. Armour Research Foundation). October 31, 1960. 27p. Contract No. AT(11-1)-578.

Study of the mechanisms associated with radioinduced synthesis in selected two-component systems containing toluene plus a halogenated compound is reported. Quantitative data on the radiolysis of mixtures of toluene with CF_4, SiF_4, SF_6, or CCl_4 are included. Experiments with the systems toluene-BF_3, $SiCl_4$, and CBr_4 are also described. Results of the gas-phase radiolysis of the mixtures of toluene with CF_4 are listed in tables and are also presented graphically. (J.R.D.)

8817 (CF-59-9-15) THE EFFECTIVENESS OF CUPRIC ION AS A HOMOGENEOUS CATALYST IN THE UO_3-HNO_3-H_2O SYSTEM FOR THE RECOMBINATION OF HYDROGEN AND OXYGEN PRODUCED BY RADIOLYTIC DECOMPOSITION. M. J. Kelly, M. D. Silverman, H. H. Stone, and G. M. Watson (Oak Ridge National Lab., Tenn.). Sept. 3, 1959. 8p.

The effectiveness of cupric ion as a catalyst in a UO_3-HNO_3-H_2O fuel system is shown by experimental data. Comparisons are made of the catalytic activity of cupric ion in the nitrate fuel solution and the presently used sulfate system. Calculations are made, using reasonable assumptions, of the permissible power density in watts per cubic centimeter at several temperatures. (auth)

8818 (CF-59-9-113) THE RADIOCHEMISTRY OF ARSENIC. Harold C. Beard (Oak Ridge National Lab., Tenn.). Sept. 3, 1959. 41p.

Properties of the element arsenic which would be of value to the radiochemist are annotated. Procedures for radioactivation analysis of arsenic were studied and evaluated. These procedures are appended and criticisms of present methods are presented. A suggested general procedure for the radioactivation analysis of arsenic is included. (auth)

8819 (JAERI-1013) STUDIES ON PREPARATION OF PHOSPHORUS-32. Kenjiro Kimura, Tomitaro Ishimori, Kenji Yoshihara, and Haruto Nakamura (Japan Atomic Energy Research Inst., Tokyo). Oct. 1960. 18p.

Phosphorus-32 is easily and quantitatively separated from the bulk of sulfur targets by shaking carbon disulfide solutions of neutron irradiated sulfur with dilute ammonia. Extraction with acid solution gives a lower recovery. Bromoform is another solvent for sulfur, however, the low solubility of sulfur in it is not desirable. From the aqueous extract, P^{32} is purified by either ion-exchange or solvent extraction. In the ion-exchange method P^{32} adsorbed on an anion-exchanger column as orthophosphate is eluted with 0.05N hydrochloric acid. Initial small fraction of the eluate is taken as the product. Preliminary removal of the impurity by cation exchange is recommended for processing large quantities of sulfur. In the solvent extraction method, the acidified extract is shaken twice with butyl acetate after addition of a small quantity of ammonium molybdate. Phosphorus-32 is re-extracted with water. For the processing of P^{32}, the ion-exchange method is more convenient than the solvent extraction method. According to the carbon disulfide-ammonia extraction followed by ion-exchange purification, the product of P^{32} was obtained with a recovery of 92%. The radiochemical purity was high. (auth)

8820 (NAS-NS-3016) THE RADIOCHEMISTRY OF PROTACTINIUM. H. W. Kirby (Mound Lab.). Dec. 1959. 85p.

"Nuclear Science Series" of the National Research Council. Committee on Nuclear Science.

8821 (NAS-NS-3018) THE RADIOCHEMISTRY OF MANGANESE. G. W. Leddicotte (Oak Ridge National Lab.). Oct. 1960. 27p.

"Nuclear Science Series" of the National Research Council. Committee on Nuclear Science.

8822 (NAS-NS-3019) THE RADIOCHEMISTRY OF CARBON, NITROGEN, AND OXYGEN. J. Hudis (Brookhaven National Lab.). Dec. 1960. 24p.

"Nuclear Science Series" of the National Research Council. Committee on Nuclear Science.

8823 (NYO-2528) A STUDY OF THE MECHANISM OF RADIATION INDUCED REACTIONS OF ORGANIC POLYMERS WITH INORGANIC SALTS AND ORGANOMETALLIC COMPOUNDS. Quarterly Summary Report [for] October 1, 1960-December 31, 1960. (Radiation Applications Inc., Long Island City, N. Y.). Feb. 1, 1961. 11p. Contract AT(30-1)-2318.

It was found that methanol accelerates the grafting of methyl acrylate to high-density polyethylene, polypropylene, teflon, and nylon. Acetone accelerates grafting of this monomer to polyvinyl chloride. The grafting of styrene to polyvinyl chloride is accelerated by methanol. The grafting of t-butylaminomethacrylate to low-density polyethylene is accelerated by n-hexane. The solubility of styrene-methanol mixtures in low-density polyethylene was determined. These data were used in conjunction with previously obtained grafting data to investigate the kinetics of grafting in this system. (auth)

8824 (NYO-9416) A COMPARISON OF RADIATION-INDUCED GRAFT COPOLYMERIZATION UTILIZING ELECTRON ACCELERATORS AND ISOTOPE SOURCES AS RADIATION INITIATORS. Quarterly Report for the Period July 18 to October 17, 1960. (Radiation Applications Inc., Long Island City, N. Y.). Dec. 1, 1960. 8p. Contract AT (30-1)-2636.

The grafting of methacrylic acid, styrene (2:1 mole ratio) co-monomer mixture on polypropylene film and fabric, was studied to compare electron accelerators and isotopes as sources of radiation. An aluminum block that contains 1/8-in.-deep pockets covered with Mylar film for holding sample and monomer during mutual irradiation was developed. A preliminary comparison was made in post grafting polypropylene film and fabric preirradiated with Co^{60} and with an electron accelerator source. It was found that post grafting was rapid at 80°C but slow at room temperature. Monomer equilibration before irradiation increased the grafting rate. Higher grafts were obtained when samples were irradiated in sparged and sealed containers. The grafting rate increased as dose rate decreased. (T.R.H.)

8825 (NYO-9417) A COMPARISON OF RADIATION-INDUCED GRAFT COPOLYMERIZATION UTILIZING ELECTRON ACCELERATORS AND ISOTOPE SOURCES AS RADIATION INITIATORS. Quarterly Report for the Period October 18, 1960 to January 17, 1961. (Radiation Applications Inc., Long Island City, N. Y.). Jan. 31, 1961. 4p. Contract AT(30-1)-2636.

A comparison of the grafting of a 2:1 molar mixture of methacrylic acid and styrene to both polypropylene film and fabric using Co^{60} source and electron accelerator as sources of ionizing radiation is made on the basis of mutual or simultaneous grafting and postirradiation grafting. (For preceding period see NYO-9416.) (auth)

8826 (RRL-53) FUNDAMENTAL RESEARCH NO. 205, QUARTERLY REPORT, OCTOBER 1, 1960–DECEMBER 31, 1960. (Mellon Inst. Radiation Research Labs., Pittsburgh). Jan. 6, 1961. 13p. Contract AT(30-1)-2310.

Studies of methyl radical production in the radiolysis of 2,2,4-trimethylpentane were extended to a number of other hydrocarbons. It was shown that an important reaction occurring during the radiolysis of liquid hydrocarbons is the addition of hydrogen atoms to unsaturated hydrocarbons. Photolysis of phosgene in the presence of ethylene and propylene was studied. The use of H^3 iodide as a radical scavenger was studied. (W.L.H.)

8827 (TID-6725) PROGRESS REPORT ON SOLID STATE POLYMERIZATION INITIATED BY GAMMA RADIATION. H. Morawetz, I. Rubin, N. Morosoff, and J. Lando (Brooklyn. Polytechnic Inst.). 18p. Contract AT(30-1)-1715.

The kinetics of the polymerization of potassium, sodium, and lithium salts of acrylic acid exposed at −78°C to radiation from a Co^{60} source was studied over a range of temperatures, following both the yield and the molecular weight of the polymer as a function of time. A number of alkaline-earth salts of acrylic or methacrylic acid were prepared in the anhydrous or various hydrated forms. The polymerizability of these materials sealed under air and exposed to a dose of 800,000 rads at −28°C is given. Polymerization kinetics of vinyl stearate purified by repeated recrystallization was studied. (W.L.H.)

8828 (TID-6917) EFFECT OF MODERATORS ON THE (n,γ) ACTIVATED REACTION OF Br^{80} WITH CH_4. Edward P. Rack and Adon A. Gordus (Michigan. Univ., Ann Arbor.). 16p. Contract No. AT(11-1)-912.

A portion of Br^{80} (13.3 ± 0.5%) produced by the $Br^{79}(n,\gamma)Br^{80}$ process was found to react with an excess of gaseous methane to become stabilized as organic activity. Varying amounts of inert gases, Br_2, C_2H_5Br, CF_4, and C_2F_6 were added to determine the manner in which these additives moderate the reaction of Br^{80} with CH_4. These data suggest that the reaction with methane occurs principally, if not completely, as a result of the recoil kinetic energy acquired by the Br^{80} in the (n,γ) activation process. (auth)

8829 (TID-11012) EFFECT OF INERT-GAS MODERATORS ON THE (n,γ) ACTIVATED REACTION OF I^{128} WITH CH_4. Edward P. Rack and Adon A. Gordus (Michigan. Univ., Ann Arbor). 20p. Contract No. AT(11-1)-912.

Of the I^{128} formed by (n,γ) activation in the presence of a large excess of gaseous methane 54.4 ± 0.5% was found to become stabilized in organic combination. The effects of inert-gas additives in moderating the reaction of I^{128} with CH_4 were determined in an effort to ascertain the mechanism. The data, extrapolated to zero mole-fraction methane, indicate that xenon is capable of reducing the organic I^{128} to 11% whereas neon, argon, and krypton each reduce it to only about 36%. These data suggest that of the 54.4% organic I^{128}, about 18.4% forms as a result of hot I^{128} reactions, 11% as a result of excited iodine atoms or I^+ ions in the $^3P_2$, $^3P_1$, and/or $^3P_0$ states, and 25% as a result of reactions of I^+ ($^1D_2$) ions. (auth)

8830 (TID-11753) RESONANCE IN RADIATION EFFECTS. Technical Report No. 5. Henry J. Gomberg (Michigan. Univ., Ann Arbor. Michigan Memorial-Phoenix Project). Nov. 1960. 46p. Contract AT(11-1)-684.

Data are included from studies on the radioinduced deactivation of catalase and the effects of monochromatic x radiation on the decomposition of liquid n-butyl bromide and of a solid organic mercury compound, α-acetoxy-mercuri-β-methoxy hydrocinnamic ethyl ester. The design and construction are described of a total-absorption thermal calorimeter, a filter unit for producting monochromatic x rays, and an optical apparatus for determinating the expansion of KCl crystals irradiated with monochromatic x rays. (C.H.)

8831 (NP-tr-549) VULCANIZATION UNDER THE INFLUENCE OF NUCLEAR RADIATION. (Vulkanizatsiya pod Vozdeystviyem Yadernykh Izluchenly). Z. N. Tarasova, M. Ya. Kaplunov, B. A. Dogadkin, V. L. Karpov, and A. Kh. Breger. Translated from Kauchuk i Rezina, 17: No. 5, 14-21(1958). 18p.

The structure and properties of radiation vulcanizates of sodium–butadiene, natural, butadiene–styrene, and isoprene rubbers and of loaded stocks of natural rubber were investigated. The vulcanizates were obtained by irradiation in a nuclear reactor and by a Co^{60} source at an integral dose of 10^7 to 10^8 r. The density of the vulcanization network formed during radiation vulcanization is determined by the dose of absorbed energy, type and composition of the rubber, filler, softener, and antioxidant content of the mix, irradiation conditions, and certain other factors. Radiation vulcanizates have better thermal and mechanical resistance than vulcanizates containing thiuram. The conditions for obtaining solid and multilayer specimens during radiation vulcanization were investigated. By comparison with the best sulfur-vulcanized rubbers, the radiation vulcanizates have a higher resistance to thermo-oxidative aging, lower permanent set, lower hysteresis, higher endurance limit in alternate bending tests, and higher heat resistance. (W.L.H.)

8832 REARRANGEMENT STUDIES WITH C^{14}. X. ETHANOL-2-C^{14} FROM THE IRRADIATION OF ETHANOL-1-C^{14} WITH Co^{60} GAMMA RAYS. C. C. Lee and D. G. Lee (Univ. of Saskatchewan, Saskatoon). Can. J. Chem., 38: 2315-18(Dec. 1960).

The irradiation of aqueous solutions of ethanol-1-C^{14},

containing about 2% ethanol by weight, with up to 58.0 million rads of Co^{60} γ rays led to the formation of up to 0.49% ethanol-2-C^{14} in the alcohol recovered after irradiation. The G value of this isotope position rearrangement was about 0.04 and amounted to approximately 2% of the G value for the total amount of ethanol decomposed. Possible mechanisms for the rearrangement are discussed. (auth)

8833 THE EFFECT OF S^{35} BETA RADIATION ON THE ISOTOPIC EXCHANGE OF OXYGEN IN THE SYSTEM $Na_2SO_4^{16}-O_2^{18}$. Vikt. I. Spitsyn and V. G. Finikov. Doklady Akad. Nauk, S.S.S.R., 133: 1381-3(Aug. 21, 1960). (In Russian)

The isotopic exchange of O^{18} with $NaSO_4$ tagged with S^{35} was measured at temperatures of 600 to 800°C with specific activities of 0.08, 0.50, 1.25, 1.58, 1.94, 10, and 25 mc of S^{35} per gram of compound. The degree of exchange, the reaction rate, and the activation energy were obtained from the changes in composition of vapor phase vs. time. The incorporation of S^{35} into Na_2SO_4 led to an increase in the rate of exchange of oxygen. There is a sharp increase in the exchange with a maximum at 1.5 mc/g. Then the rate of exchange dropped sharply at 2.0 mc/g and increased slowly as the specific activity was raised from 2.0 to 25 mc/g. The activation energy went through a minimum (4 kcal/mole) at a specific activity of 1 to 2 mc/g, and then rose so sharply as to indicate a change in the reaction mechanism with the use of the more intense radioactive sources. Data are presented which show that the rate of isotopic exchange is greater, the higher is the initial specific activity and the higher is the elapsed time after incorporating the S^{35} in the Na_2SO_4. (TTT)

8834 THE MECHANISM OF GAS FORMATION DURING RADIOLYSIS OF ORGANIC SUBSTANCES AND ITS RELATION TO THE STATE OF AGGREGATION. A. B. Taubman, L. P. Yanova, R. S. Maslovskaya, and P. Ya. Glazunov. Doklady Akad. Nauk, S.S.S.R., 134: 397-9 (Sept. 11, 1960). (In Russian)

The organic compounds n-octane, n-decane, paraffin, nitrobenzene, and n-dichlorobenzene were subjected to irradiation by a beam of fast electrons at various temperatures. The dose was determined by the ferrous sulfate method and varied from $E = 2.2$ to 6.8×10^{21} ev/cm^3/hr. The amount of gas evolved from the liquid was measured as a function of temperature which was kept constant to ±4°C during the irradiation. All the substances showed a sharp decrease in the quantity of gas formed by irradiation at the freezing point which varied over a wide temperature interval of −56.5°C for n-octane to about +54°C for n-dichlorobenzene. The rate of gas formation was slowed down considerably in the solid state as compared to the liquid state. It is interesting to note that water shows an analogous behavior. (TTT)

8835 NUCLEAR RADIATION CHEMISTRY OF ORGANIC LIQUIDS. AN INTRODUCTORY SURVEY. I. D. Bertram. Isotopentechnik, 1: 18-20(Jan. 1960).

The paper deals briefly with the beam sources important to applied radiation chemistry, dosimetric problems, and the primary processes involved in the effect of radiation on organic substances. A general review of the radiation chemistry of organic liquids is then given. Emphasis is placed on the representation of the present stage of development. (auth)

8836 THE FORMATION OF BITROPYL IN THE RADIOLYSIS OF CARBON-14 LABELED CYCLOHEPTATRIENE. Gottfried Juppe and Alfred P. Wolf (Brookhaven National Lab., Upton, N. Y.). J. Am. Chem. Soc., 83: 337-40(Jan. 20, 1961). (BNL-4839).

The irradiation of C^{14}-labeled cycloheptatriene in a nuclear reactor or in a beam of 1.95-Mev from a Van de Graaff generator leads to the formation of labeled bitropyl among other products. Ozonization of bitropyl leads to dicyclopropyltetracarboxylic acid. Permanganate oxidation of bitropyl leads to benzoic acid. The extent of labeling in these degradation products suggests a symmetrical intermediate as a precursor of the dimer. (auth)

8837 POLYETHYLENE-FERROUS-ION DOSIMETER FOR HYDROCARBON SYSTEMS IN RADIATION CHEMISTRY. R. C. Palmer, R. W. Carter, and D. C. Bardwell (Georgia Inst. of Tech., Atlanta). Intern. J. Appl. Radiation and Isotopes, 9: 60-2(Dec. 1960). (In English)

A procedure for accurately determining the total energy input into an organic system was evaluated. The study was performed in the low-energy region of the x-ray spectrum (below 50 kev). This method eliminates the uncertainties encountered in the use of electron density ratios. (auth)

8838 OLEFIN POLYMERIZATION IN SOLUTIONS OF $TiCl_4$ IN N-HEPTANE IRRADIATED WITH GAMMA RAYS OR ELECTRONS. R. W. Hummel and J. Hearne (Wantage Research Lab., Berks, Eng.). Intern. J. Appl. Radiation and Isotopes, 9: 84-7(Dec. 1960). (In English)

It is shown that the polymerization of ethylene by radiation-induced catalyst formation in $TiCl_4$-heptane mixture is possible but energetically inefficient. The yield is increased by increasing the $TiCl_4$/heptane ratio but at high ratios chlorination of the polymer can be expected. Lower temperatures favor polymer formation. Polymerization of propylene by the same process gives relatively large amounts of oily products and very little solid polypropylene. (auth)

8839 GAMMA IRRADIATION OF SOME UNSATURATED STEROIDS. H. Fazakerley (Wantage Radiation Lab., Berks, Eng.). Intern. J. Appl. Radiation and Isotopes, 9: 130-1(Dec. 1960). (In English)

The chemical and physical effects of γ radiation on some steroids, mainly in the powdered form, were investigated. The steroid hormones, cortisone, prednisone, and progesterone, were found to show high stability to radiation damage to supersterilization doses (6 to 18 Mrad) both in presence and absence of air. Ergosterol and calciferol were found to be sensitive to radioinduced oxidation in air, and their oxidation products were characterized. These reactions of ergosterol and calciferol probably proceed by a free radical chain process since the G value for product formation exceeds 20. (D.L.C.)

8840 MOLECULAR SIZE DISTRIBUTION AND GELATION OF IRRADIATED COPOLYMERS. Mitio Inokuti (Univ. of Tokyo, Japan). J. Chem. Phys., 33: 1607-15 (Dec. 1960).

A theory is developed about the molecular size distribution in a system of copolymers which are composed of two different kinds of monomer units and undergo random crosslinking when exposed to high-energy radiations. The radiation-induced change in the molecular size distribution is described by an integrodifferential equation, which is solved exactly by means of Laplace transform for an arbitrary initial distribution to obtain the number average as well as the weight average degree of polymerization as a function of radiation dose. Further, the gel point, or the dose required for incipient gelation, is given as a function of concentrations of the monomer units constituting the copolymeric system. The present theory, which also involves the problem of crosslinking in a mixture of two kinds of polymers as a special case, leads to a condition for gelation of such a mixture due to irradiation when crosslinking competes with main-chain scission. This

condition proves to be completely independent of the initial distribution. (auth)

8841 BEHAVIOR OF THE FREE RADICALS TRAPPED IN GAMMA-IRRADIATED COMPOUNDS WHICH CONTAIN HYDROGEN BONDS. Zenichiro Kuri, Yuzuru Fujiwara, Hisashi Ueda, and Shoji Shida (Japanese Assoc. for Radiation Research on Polymers, Tokyo). J. Chem. Phys., 33: 1884-5 (Dec. 1960).

A series of experiments was performed which suggest that the nonreactivity of gaseous scavengers with free radicals in certain irradiated compounds is not due to inherent free radical stability but to a network of intermolecular hydrogen bonds which prevents penetration by gases. These experiments, performed on polyvinyl alcohol, cellulose, starch, arabinose, ribose, xylose, glucose, fructose, sorbose, galactose, sucrose, cellobiose, lactose, inulin, and glutamic acid demonstrated that free radicals in these compounds, although inert to gaseous scavengers, decay rapidly near the melting point or in the presence of water and react with monomers in presence of water. (D.L.C.)

8842 NITRIC OXIDE AS A RADICAL SCAVENGER IN THE RADIOLYSIS OF GASEOUS HYDROCARBONS. Kang Yang (Continental Oil Co., Ponca City, Okla.). J. Phys. Chem., 65: 42-5(Jan. 1961).

Nitric oxide reduces energy yields of various products in the radiolysis of gaseous hydrocarbons. These yield reductions can be explained by assuming that nitric oxide scavenged thermalized radicals or that nitric oxide interfered with processes not involving thermalized radicals (such as ionic reactions). Attempts to determine what part of the nitric oxide effect must be attributed to the latter cause were not successful. However, experimental evidence was found that as much as 10 mole % nitric oxide has a negligible effect on the product yields of the processes which do not involve thermalized radicals: (1) processes yielding hydrogen in the radiolysis of methane, ethylene, propylene, and cyclopropane; (2) processes yielding ethylene in the radiolysis of propylene. These results show that, at least in certain situations, nitric oxide can be used to estimate unambiguously the thermalized radical contributions. (auth)

8843 THE DECOMPOSITION OF SOLID H_4N_2 INDUCED BY CHARGED PARTICLE BOMBARDMENT. Harold A. Papazian (Convair Scientific Research Lab., San Diego, Calif.). J. Phys. Chem., 65: 53-5(Jan. 1961).

The decomposition of solid hydrazine induced by ion and electron bombardment was studied. The decomposition was found to proceed through several steps. The stepwise evolution of N_2, H_2 and NH_3 during warm-up of the bombarded solid was measured. The absorption spectrum of the bombarded solid showed the absence of NH_2. The results indicate the formation of nitrogen compounds such as triazene which are stabilized at low temperatures and which decompose during warm-up of the solid. (auth)

8844 THE ACTION OF OXYGEN ON IRRADIATED POLYVINYL CHLORIDE. Billy R. Loy (Dow Chemical Co., Midland, Mich.). J. Phys. Chem., 65: 58-61(Jan. 1961).

The formation and decay of the peroxy radical produced in irradiated poly-(vinyl chloride) is studied by electron spin resonance spectroscopy over a temperature range from −78 to +45°C. The two reactions are studied independently making use of the difference in reaction rates. The exponential formation reaction is thought to be diffusion controlled. The apparent first-order decay reaction is interpreted as an autoöxidation process which gives mobility to the unpaired electron. (auth)

8845 THE STUDY OF THE FRAGMENTATION OF LONG-CHAIN PARAFFINS UNDER ELECTRON BOMBARDMENT USING ISOTOPICALLY LABELLED COMPOUNDS. J. H. Beynon, R. A. Saunders, A. Topham, and A. E. Williams (I. C. I. Dyestuffs Div., Manchester, Eng.). J. Phys. Chem., 65: 114-18(Jan. 1961).

Study of C^{13} abundance in the various fragments obtained from labeled compounds enables various hypotheses as to the mode of fragmentation to be tested. It is shown that results obtained on samples of n-heptadecane-I-C^{13} and n-eicosane-4-C^{13} do not support the postulate that abundant peaks are formed by simple carbon-carbon bond rupture. It appears that a multi-stage fragmentation process involving ring formation may be occurring. (auth)

8846 RADIOLYSIS OF METHANE IN THE PRESENCE OF OXYGEN. THE FORMATION OF METHYL HYDROPEROXIDE. G. R. A. Johnson and G. A. Salmon (Wantage Research Labs., Berks, Eng.). J. Phys. Chem., 65: 177-8 (Jan. 1961).

Methane containing 0.1, 1.0, and 10.0 mole % oxygen was irradiated with low doses ($< 4 \times 10^{16}$ ev/ml) and the methyl hydroperoxide and total peroxide yields determined. The G (methyl hydroperoxide) ~3.5 was found to be equal to G (total peroxide) within experimental error and to be independent of the oxygen concentration. The results are discussed in terms of reaction mechanisms. (D.L.C.)

8847 KINETICS OF RADIATION-INDUCED CHEMICAL REACTIONS. J. P. Keene (Christie Hospital and Holt Radium Institute, Manchester, England). Nature, 188: 843-4(Dec. 3, 1960).

The apparatus and preliminary results are described for experiments in which various aqueous solutions were subjected to 2 μsec pulses of 4-Mev electrons from a linear accelerator. The rate at which changes occur was measured in 5×10^{-5}M ceric sulfate and three molar strengths (10^{-1}, 10^{-3}, and 10^{-4}) of ferrous ammonium sulfate. Ceric sulfate absorbs light at 3350 Å and is reduced to the nonabsorbing cerous form by the radiation. Ferrous ammonium sulfate is transparent in the ultraviolet and is oxidized to the ferric form which has a broad absorption band with a maximum at 3100 Å. After a single electron pulse the optical transmission of ceric sulfate at 3350 Å increased with a half-time of ~100 μsec to a steady value; for ferrous ammonium sulfate at 3150 Å, the transmission decreases to a steady value at half-times of 98 μsec for 10^{-1}M Fe^{2+}, 1050 μsec for 10^{-3}M Fe^{2+}, and 1.04×10^4 μsec for 10^{-4}M Fe^{2+}. (B.O.G.)

8848 REVERSIBLE BEHAVIOUR OF THE ULTRAVIOLET IRRADIATED DEOXYRIBONUCLEIC ACID AND ITS APURINIC ACID. Shih Yi Wang (Tufts Univ. School of Medicine, Boston, Mass.). Nature, 188: 844-6. (Dec. 3, 1960).

The changes produced by ultraviolet irradiation in thymidylic acid (A), deoxycytidylic acid (B), apurinic acid (C), deoxyribonucleic acid (D), a 1:1 mixture of A and B, and the reversibility of the changes in C and D, are described. The results indicate the optical density decrease of the mixture (A + B) is approximately one-half the sum of the two irradiated individually. When the two acids, A and B, together exist in polymeric form, as apurinic acid (C), the decrease in optical density is more than three times that of the monomeric mixture. Suggestions were made concerning the causes of the discrepancy. Irradiation and heat and acid reconstitution curves are given for C and D. The increase in optical density in the spontaneous reconstitution of D reached 0.005 as a maximum value on standing for

~3 hr. For heat reconstitution, the value reached 0.092. The portion reconstituted was found to be ~50%. For apurinic acid, spontaneous reconstitution reached 0.118 in 8 hr, while heat reconstitution reached 0.240, which is ~60% reconstitution. In acid or acid and heat reconstitution, the values were somewhat lower and the absorption maximum shifted from 260 to 262 mμ in both cases. (B.O.G.)

8849 GLASS FORMATION IN SOLUTIONS OF HYDROGEN PEROXIDE–WATER AND DEUTERIUM PEROXIDE–HEAVY WATER. Robert C. Smith and S. J. Wyard (Guy's Hospital Medical School, London). Nature, 189: 211-12 (Jan. 21, 1961).

A H_2O solution containing 45.5 to 87 wt.% H_2O_2 was found to form a glass when immersed in liquid oxygen (90°K). The boundary between crystallization and glass formation at 45.5 wt.% is very sharp and corresponds to the eutectic point of H_2O and H_2O_2, while the boundary at 87 wt.% is less marked with a leeway of ± 5 wt.% and coincides with the change in the slope of the melting point vs. concentration curve for quickly frozen solutions. The effects of warming on the frozen glass samples were studied and explained in terms of exothermic crystallization and melting. A D_2O solution containing 80 wt.% D_2O_2 was also found to form a glass in liquid oxygen, with no evidence of subsequent crystallization reported in earlier work. (D.L.C.)

8850 PRODUCTION OF PYRAZINE DERIVATIVES IN THE RADIOLYSIS OF AQUEOUS SOLUTIONS OF THE CYCLIC DIPEPTIDES. Mathilde Kland-English and Warren M. Garrison (Univ. of California, Berkeley). Nature, 189: 302(Jan. 28, 1961). (UCRL-9490)

A study was made on the effects of γ radiation on the ultraviolet absorption spectra of solutions of various simple peptides. The measurements reveal that solutions of the cyclic dipeptides under specific conditions exhibit pronounced and characteristic postirradiation changes. Results are included on the effects of pH and oxygen content on the properties of irradiated solutions of glycine anhydride. Possible reaction mechanisms are discussed. (C.H.)

8851 THE CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS OF POLYVALENT ATOMS IN ORGANIC LIQUIDS. Krystyna E. Siekierska, Aleksander Halpern, and Andrzej Siuda (Inst. of Nuclear Research, Warsaw). Nukleonika, 5: 635-47(1960). (In English)

Some of the data in the literature on the effects following nuclear transformations of polyvalent atoms in organic liquids are summarized. Some new data concerning phenylarsenic and butylphosphorus compounds are presented which show that the organic bond reformation by polyvalent recoil atoms is a consecutive process. (auth)

8852 CHEMICAL EFFECTS WHICH ACCOMPANY THE ORIGIN AND DECAY OF A RADIOACTIVE ATOM IN THE PRESENCE OF ORGANIC MOLECULES. Giordano Giacomello (Univ., Rome, Italy). Ricerca sci., 30: 1449-79(Oct. 1960). (In Italian)

The principal chemical effects caused in organic systems by different kinds of radiation emitted by radioisotopes are reviewed, and the effects of fission, substitution, and polymerization caused by the recoil energy of the radioactive atom are described. 41 references. (tr-auth)

8853 RADIOLYSIS OF HYDROCARBON COMPOUNDS BY COBALT 60 GAMMA-RADIATION. Motome Hamashima. Tokyo Kôgyô Shikensho Hôkoku, 54: 363-7(Nov. 1959). (In Japanese)

Radiolysis of cyclohexane and 2,2-dimethylpropane were studied at the temperature from 25 to about −60°C and that of n-hexane, 2,4-dimethylpentane, 2,2,4-trimethylpentane, and polystyrene at 25°C were also studied. G values of hydrogen and methane from these compounds were observed in the temperature ranges. (auth)

8854 THE RADIATION CHEMISTRY OF LIQUID AMMONIA. D. Cleaver, E. Collinson, and F. S. Dainton (Univ. of Leeds, England). Trans. Faraday Soc., 56: 1640-55 (Nov. 1960).

The radiolyses of pure liquid ammonia and of dilute ammonia solutions of sodium, methylene blue, ammonium chloride, potassium chloride, and sodamide were investigated. The results indicate that the major primary radicals are hydrogen atoms and NH_2 radicals, which probably have identical spatial distributions. After the diffusion and combination processes have taken place, the yields per 100 ev of Co^{60} γ-ray energy of the various species available to react with solutes are given by the equation $2.0\ NH_3 \sim\sim\rightarrow 1.75\ H\cdot + 1.75\ \cdot NH_2 + 0.125\ H_2 + 0.125\ N_2H_4$. The differences between this equation and the corresponding one for water are considered to arise from the larger fraction of secondary electrons which return to the δ-ray tracks and positive ions, as compared with water where a significant fraction of the electrons do not return but produce hydrogen atoms, or their stoichiometrical equivalents, by reaction with water molecules. (auth)

8855 THE EFFECTS OF γ RADIATION UPON ELECTRODE SYSTEMS. PART 1. PLATINUM ELECTRODES IN PURE WATER AND AQUEOUS SULPHURIC ACID. F. S. Feates (Atomic Energy Research Establishment, Harwell, Didcot, Berks, Eng.). Trans. Faraday Soc., 56: 1671-9 (Nov. 1960).

The effects of γ radiation on smooth platinum electrodes in aqueous solutions are reported. Characteristic changes in rest potential are shown to arise from competition for adsorption sites on the metal surface by radiolytically generated hydrogen and hydrogen peroxide. The potential-determining species in H_2O_2 solutions was shown to be the HO_2 radical. Changes in the kinetics of the hydrogen evolution reaction were studied and are very sensitive to electrode pretreatment. Large changes of Tafel slope are reported for electrodes prepared in the presence of air, but much smaller changes for electrodes prepared in hydrogen. This is interpreted in terms of the differing sensitivities of the electrode surfaces to hydrogen and hydrogen peroxide. Differential irradiation of the electrochemical cell was studied as a possible means of direct conversion of radiation energy into electrical energy, and an efficiency of 1.3% was achieved. (auth)

8856 THE EFFECTS OF γ RADIATION UPON ELECTRODE SYSTEMS. PART 2. AQUEOUS REDOX SYSTEMS. F. S. Feates and B. Knight (Atomic Energy Research Establishment, Harwell, Berks, England). Trans. Faraday Soc., 56: 1680-96 (Nov. 1960).

The radiolytic oxidation of ferrous sulfate was studied in detail by a potentiometric method. Aftereffects, previously attributed to a postirradiation oxidation, are shown to arise from a change in the concentration of radiolytically generated hydrogen which has been found to be an important potentiometrically active species throughout the whole course of oxidation. The equilibrium potential ultimately attained during the irradiation of aqueous redox systems is shown to be due to the effects of hydrogen peroxide and not, as previously reported, to an equivalent redox potential. The equivalent redox potential concept could not be confirmed because a sufficiently effective and specific hydrogen peroxide scavenger which was not electrochem-

ically active was not available. Consideration of the practicability of monitoring the oxidation potentiometrically for dosimetry purposes showed that the method is only suitable when a platinized platinum electrode is used in a solution rapidly swept with argon. In other cases, the electrode potentials are not defined by the redox constituents of the solution. (auth)

8857 ENERGY DISSIPATION IN RADIOCHEMISTRY. Milton Burton (Univ. of Notre Dame, Ind.). Z. Elektrochem. 64: 975-82(1960). (In German)

The dissipation of the energy absorbed for radiochemical reactions is discussed in detail. Primary effects, excitation and ionization, are treated first, then secondary effects such as decomposition. This is followed by consideration of G-value contrasts, lifetimes of excited molecules, energy transfer mechanisms, and sensitized decomposition. (T.R.H.)

8858 PHOTO AND RADIOCHEMICAL DECOMPOSITION OF HYDROGEN PEROXIDE IN THE PRESENCE OF IRON OXIDE. D. M. Shub, G. S. Tyurikov, and V. I. Veselovskii (Karpov Inst. of Physics and Chemistry, U.S.S.R.). Zhur. Fiz. Khim., 34: 2245-53(Oct. 1960). (In Russian)

The rate of decomposition of concentrated aqueous solutions of hydrogen peroxide in the presence of iron oxide (Fe_2O_3) suspensions under the action of ultraviolet light and γ radiation was determined. It was found that in the presence of a semiconductor sensitizer (Fe_2O_3) the photo and radiation decomposition of hydrogen peroxide changes greatly in comparison with the reaction in the absence of a sensitizer. The phenomenon was interpreted on the grounds that light (as well as γ quanta) absorbed by the semiconductor sensitizer (Fe_2O_3) excites on its surface the active particles that subsequently initiate the chain decomposition of H_2O_2 in the bulk of the solution. Hence a heterogeneous semiconductor sensitizer sharply enhances the chemical efficiency of radiation acting on the system. (auth)

8859 PROTECTIVE ACTION OF WATER IN THE RADIOLYSIS OF STARCH. V. F. Oreshko (Moscow Technological Inst. of Food Industry, U.S.S.R.). Zhur. Fiz. Khim., 34: 2369(Oct. 1960). (In Russian)

The protective effects of water in starch irradiated by Co^{60} γ rays were investigated. It was found that with the increase of the starch moisture the energy for breaking the bond between the glucopyronose ring in the starch molecule polymer chain increases continually and follows the equation derived by the least squares method $E_d = 6.5 \pm 1.45\ W_v$ (W_v is the % of moisture). For dry starch $W_v = 0$, $E_d = 6.5$ ev. The protective action of water is the result of hydrogen bond between the functional glucopyronose rings and water molecules. The energy necessary for breaking the bond of starch with $W_v = 16.6\%$ at a dosage of 2000 r/min is plotted. The energy E_d does not depend on the dosage. (R.V.J.)

8860 CHEMICAL REACTIONS PERFORMED BY ENERGY OF FISSION PRODUCTS. (to Société Belge de l'Azote et des Produits Chimiques du Marly). French Patent 1,214,259. Apr. 7, 1960.

Chemical reactions are performed in gaseous reagents by the energy of fission products, these reagents being brought in contact with microporous nuclear fuel having a high specific free surface. The fissile material, e.g., uranium dioxide, may be dispersed in a microporous supporting mass constituted by activated charcoal, aluminum oxide, synthetic reolite, silica gel, or kieselguhr, the supporting materials having low neutron-capture cross sections. These reactions are preferably performed under high pressure in a power reactor. (NPO)

Raw Materials and Feed Materials

8861 (FMPC-524) THE EVALUATION OF THE MOVING BED REACTOR FOR THE PRODUCTION OF URANIUM TETRAFLUORIDE. Interim Report. H. F. Muhlhauser, D. J. Loudin, G. G. Briggs, and E. W. Mautz (National Lead Co. of Ohio, Cincinnati). Jan. 1, 1955. Decl. Mar. 31, 1960. 114p. Contract AT(30-1)-1156.

A moving bed pilot plant reactor (MBR) for the production of uranium tetrafluoride from uranium trioxide was designed and erected in the UF_4 plant. A preliminary evaluation of the moving bed process is presented. In conjunction with the reactor development studies, several methods of pellet feed fabrication were also evaluated. These methods included extrusion, casting in a moving molding belt, fabrication on a finned rotary drum, and nodulizing in a rotary drum. (auth)

8862 (NLCO-645) AMMONIA PRECIPITATION AND FILTRATION STUDIES FROM URANYL NITRATE SOLUTION. Philip S. Gentile and Thomas J. Collopy (National Lead Co. of Ohio, Cincinnati). Aug. 15, 1956. Decl. Mar. 31, 1960. 17p. Contract AT(30-1)-1156.

Laboratory precipitation and filtration tests were performed to determine the conditions for producing an easily filterable uranium cake when NH_4OH is added to a solution of $UO_2(NO_3)_2$. The laboratory investigation demonstrated that good conditions for production of a filterable uranium precipitate include a pH of 9.8 before filtration, addition of the NH_4OH to the $UO_2(NO_3)_2$ solution (in preference to addition of the $UO_2(NO_3)_2$ solution to NH_4OH), and an $UO_2(NO_3)_2$ solution of a strength of about 160 g/l uranium. Concentrated NH_4OH (28% NH_3) should be used at a precipitation temperature of 150°F. Minimum aging prior to filtration is efficacious as are a stirring rate sufficient to maintain the precipitate in homogeneous suspension and a rate of agitation which will minimize localized pH changes. The results of an evaluation of filter cloths showed that nylon gives the best filtration rate and precipitate retention and has the best resistance to abrasion. (auth)

8863 (RCN-2) A STABILIZED URANIUM OXIDE FOR SINTERING PURPOSES. B. Verkerk and G. H. Brouwer (Netherlands. Reactor Centrum, The Hague.). [nd]. 14p.

A method is described to produce a nonpyrophoric uranium dioxide powder with adequate sintering properties. Ammonia or urea precipitated ADU-products are reduced in hydrogen and immediately afterwards slightly oxidized by water vapor at the same temperature. It was found that the excess oxygen in the dioxide powders obtained only slightly changed during a period of months. Powders with initial composition $UO_{2.04}$ and surfaces of 2 to 3 m^2/g oxidized to $UO_{2.08}$ in a period of $\frac{1}{2}$ year. Pressing characteristics of the water vapor-oxidized powders were significantly better than those of untreated powders from the same starting materials. X-ray diagrams showed the presence of a U_3O_8-like phase so the formation is postulated of a thin nonporous U_3O_8 layer during water vapor treatment, preventing the further oxidation of the powder. (auth)

8864 STUDY OF THE RECOVERY OF URANIUM AND COPPER FROM THE MINERALS OF SANTA MARIA DE LA CABEZA. P. Gasós, J. M. Jósa, A. P. Luña, and L. G.

Jodra (Junta de Energia Nuclear, Madrid). Anales real soc. españ. fís. y quím. (Madrid), Ser. B, 56: 811-32(Sept.-Oct. 1960). (In Spanish)

The bench scale experiments carried out on the ores from Santa Maria de la Cabeza (Jaén) to recover copper and uranium are described. Two types of ores were studied: "Brown" (8.8% CuO and 0.093% U_3O_8) and "Black" (22% CuO and 0.40% U_3O_8). This study was made following conventional or statistical methods (factorial design). Results from sulfuric acid leaching, solid-liquid separation, recovery of solubilized elements, and flotation of the ore and the leaching tailings are included. From these results flowsheets, now under study in pilot-plant scale, were prepared. (auth)

8865 ON THE REACTIVITY OF URANOURANIC OXIDE(IV). Rokuo Ukazi (Osaka Metal Ind. Co., Yodogawa Works, Japan). J. At. Energy Soc. Japan, 2: 598-602(1960). (In Japanese)

The influence of the surface structure on the reactivity of uranouranic oxides(I), (II), and (III) was studied both by the electron microscope using replica technique and the x-ray diffractometer. U_3O_8 (I-III) were prepared from uranyl nitrate, ammonium diuranate, and uranium peroxide, respectively. U_3O_8(I) particles were about 1 to 2 μ without heating, and sometimes grew up to about 10 μ by heating in the air at 900°C for 2 hr. For U_3O_8(II) and (III) particles there was no remarkable difference in the surface structure. These particles were 0.3 to 0.4 μ without heating, but grew up to 1 μ by heating in the air at 900°C for 2 hr. The diameters of these particles calculated from the specific surface area were similar to the results obtained by the replica method. Line broadening was not observed in any faces of U_3O_8(I). Broadening was observed especially in (201) line of U_3O_8(II) but decreased on heating and disappeared above the vicinity of 850°C. Broadening was also observed in (201) and (020) lines of U_3O_8(III), and these broadenings decreased very little after heating. (auth)

Separation Processes

8866 (CF-59-4-108) TRANSURANIC STUDIES STATUS AND PROBLEM STATEMENT. R. E. Leuze (Oak Ridge National Lab., Tenn.). Apr. 29, 1959. 14p.

The purpose of the Transuranics Program is to develop separation processes for the transuranic elements, primarily those produced by long-term neutron irradiation of Pu^{239}. The program includes laboratory process development, pilot-plant process testing, processing of 10 kg of Pu^{239} irradiated to greater than 99% burn-up for plutonium and americium-curium recovery, and processing the reirradiated plutonium and americium-curium fractions. The proposed method for processing highly irradiated plutonium is: (1) plutonium-aluminum alloy dissolution in HNO_3; (2) plutonium recovery by TBP extraction; (3) americium, curium, and rare-earth extraction by TBP from neutral nitrate solution; (4) partial rare-earth removal (primarily lanthanum) by americium-curium extraction into 100% TBP from 15M HNO_3; (5) additional rare-earth removal by extraction in 0.48M mono-2-ethylhexylphosphoric acid from 12M HCl; and (6) americium-curium purification by chloride anion exchange. Processing through the 100% TBP, 15M HNO_3 cycle can be carried out in the Power Reactor Fuel Reprocessing Pilot Plant. New facilities are proposed for laboratory process development studies and the final processing of the transplutonic elements. (auth)

8867 (CF-59-8-29) THE USE OF BORON FOR FLUORIDE COMPLEXING IN THOREX DISSOLVER SOLUTIONS. F. G. Kitts (Oak Ridge National Lab., Tenn.). Aug. 6, 1959. 5p.

Preliminary measurements of the corrosion of titanium were made in 13M HNO_3–0.05M fluoride using 0.1M H_3BO_3 as a liquid and vapor-phase complexing agent. Titanium Ax-55 was attacked at average rates of 0.58 and 0.33 mil/month in the liquid and vapor. In dissolver solutions containing 0.5 and 1.0M titanium, all rates were less than 0.1 mil/month. (auth)

8868 (CF-59-8-98) URANIUM RECOVERY FROM SODIUM FLUORIDE BEDS IN THE VOLATILITY PILOT PLANT. R. A. Cross and C. L. Whitmarsh (Oak Ridge National Lab., Tenn.). Aug. 7, 1959. 7p.

A survey of possible methods for uranium recovery from sodium fluoride beds used in the Volatility Pilot Plant was conducted. This study included a literature survey and limited experimental work. Dissolution of the sodium fluoride in molten salt with subsequent fluorination of the uranium had the best potential of the methods studied for radioactive operation. However, aqueous dissolution followed by a concentration procedure appears more feasible for beds not exposed to radioactivity. (auth)

8869 (CF-59-9-5) PLUTONIUM BEHAVIOR IN THE FLUORIDE VOLATILITY PROCESS. R. A. Cross and C. L. Whitmarsh (Oak Ridge National Lab., Tenn.). Sept. 3, 1959. 8p.

The behavior of plutonium in the Volatility Process was investigated. Both a literature survey and pilot-plant experimental work were performed. Additions of 10 mg, 1 g, and 10 g of plutonium were made to the feed salt in three regularly scheduled runs. Although previous experiments indicated some volatilization of PuF_6 would occur, >99% of the plutonium remained in the salt in the fluorinator. Maximum product contamination was 3 ppb. (auth)

8870 (CF-59-11-23) LABORATORY DEVELOPMENT OF THE PERFLEX PROCESS FOR DISSOLUTION OF URANIUM ALLOY FUELS IN HYDROFLUORIC ACID-HYDROGEN PEROXIDE SOLUTIONS. T. A. Gens and W. E. Clark (Oak Ridge National Lab., Tenn). Nov. 10, 1959. 14p.

A tentative flowsheet is presented for the dissolution of 7% U-Zr-Sn alloy in HF-H_2O_2. A mixture of 34.4M HF–0.6M H_2O_2 is fed to the dissolver at a controlled rate. All the uranium and tin dissolves with the zirconium. Aluminum nitrate and nitric acid are added after dissolution to yield a stable solvent-extraction feed solution which has a higher uranium concentration and the same zirconium, aluminum, and fluoride concentration as that presently used at the Idaho Chemical Processing Plant. Hastelloy C appears to be the best material of construction, with corrosion rates of approximately 0.08 mils/cycle for the unwelded metal. Niobium dissolves readily in HF-H_2O_2. (auth)

8871 (CF-59-11-110) THERMODYNAMICS IN THE FUSED SALT DISSOLUTION PROCESS FOR ZIRCONIUM FUEL. G. I. Cathers (Oak Ridge National Lab., Tenn.). Nov. 19, 1959. 8p.

A discussion is given of the role of thermodynamics in the fused-salt volatility process, particularly as it applies to oxidation-reduction reactions affecting zirconium, uranium, nickel, chromium, ruthenium, and other elements present in the hydrofluorination head-end step. (auth)

8872 (CF-59-12-35) URANIUM–THORIUM SEPARATION BY DI-SEC-BUTYLPHENYLPHOSPHONATE EXTRACTION. A. T. Gresky and R. G. Mansfield (Oak Ridge National Lab., Tenn.). Dec. 9, 1959. 3p.

Data reported in CF-59-11-25 indicated that it was possible to attain thorium decontamination factors greater than 50 in a process employing 1M DSBPP (in Solvesso-100) as extractant, an aqueous feed containing 150 g uranium/l, 1.0 g thorium/l, and 1.0N HNO_3, an aqueous scrubbing solution of 1.0N HNO_3, and a flow ratio F/S/O = 1/0.5/1.6. An extension of this data in tests with feeds at 10 g thorium/l (to increase accuracy of analytical detection) indicates that the thorium DF's are at least 200, and may be several orders of magnitude higher with four to six stages of scrubbing. (auth)

8873 (CF-60-1-102) A REVIEW OF FACTORS BEARING ON THE NUCLEAR SAFETY OF EQUIPMENT FOR THE PRFR HEAD END FACILITY. A. R. Irvine, J. M. Holmes, A. C. Schafer, and J. P. Nichols (Oak Ridge National Lab., Tenn.). Jan. 13, 1960. 26p.

The factors considered which bear on nuclear safety are the anticipated fragmentation of ceramic fuels, means for preventing entry of finely divided fissile solids into large geometry tanks, means for detecting solids, and variations in equipment flowsheet. (auth)

8874 (CNEN-1) DESIGN OF SERIES PULSE COLUMNS PILOT PLANTS APPLIED TO THE RECOVERY AND SEPARATION OF FISSION PRODUCTS. I. Theory and Discussion. F. L. Salvetti and S. Santoli (Italy. Comitato Nazionale per l'Energia Nuclear, Ispra). October 1960. 14p.

The physical and technological concepts needed for rational design of series pulse columns are worked out. The pressure drops calculation throughout the plant is considered as essential in building up columns with low free fractional area drilled plates. The theory exposed can be used as an introduction to working with pulse columns. (auth)

8875 (DP-219) EXTRACTION OF URANIUM AND OTHER ACTINIDES FROM NITRIC ACID BY DI-N-BUTYL N-BUTYLPHOSPHONATE. Thomas H. Siddall, III (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). June 1957. Decl. Mar. 28, 1960. 20p. Contract AT(07-2)-1.

Equilibrium data are presented for the distribution of uranium, other actinides, zirconium, and HNO_3 between aqueous solutions and di-n-butyl n-butylphosphonate diluted with n-dodecane. Data for the physical properties and chemical stability of the phosphonate are also given. (auth)

8876 (DP-228) ADSORPTION OF ZIRCONIUM–NIOBIUM ON SILICA GEL. David G. Karraker and Sidney G. Parker (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). July 1957. Decl. Mar. 28, 1960. 12p. Contract AT(07-2)-1.

Adsorption of radioactive Zr and Nb from $UO_2(NO_3)_2$ solutions by silica gel was increased by increasing the temperature and time the solution contacts silica gel and decreased by "aging" the solutions before contacting the silica gel. (auth)

8877 (HW-66788) THE NITRIC ACID LEACHING OF URANIUM DIOXIDE IN A RECIRCULATING DISSOLVER. P. W. Smith (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 20, 1960. 13p. Contract AT(45-1)-1350.

A brief study of the nitric acid leaching of sheared Zircaloy and stainless-steel-clad UO_2 fuels was carried out. The study was intended to demonstrate the leaching process and the use of a removable dissolver canister for transport and charge duty. In addition, the effect of sheared element length on leaching time cycles was studied. (L.T.W.)

8878 (HW-68207) AMINE EXTRACTION OF PLUTONIUM FROM NITRIC ACID SOLUTIONS LOADING AND STRIPPING EXPERIMENTS. A. S. Wilson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan 19, 1961. 7p. Contract AT(45-1)-1350.

Information is presented on a suitable amine processing system for plutonium nitrate. Experiments with concentrated plutonium nitrate solutions show that trilaurylamine (TLA)–xylene solvent systems did not form a second organic phase. Experiments are also reported with tri-n-octylamine (TnOA)-xylene and TLA-Amsco–octyl alcohol. Two organic phases appear in both these systems at high plutonium nitrate concentrations. Data are tabulated from loading and stripping experiments. (J.R.D.)

8879 (NP-9695) SEPARATION OF VARIOUS OXIDATION STATES OF PLUTONIUM BY REVERSED-PHASE PARTITION CHROMATOGRAPHY. R. Gwóźdź and S. Siekierski (Polish Academy of Sciences. Inst. of Nuclear Research. Warsaw). September 1960. 8p.

The application of reversed-phase partition chromatography to the separation and determination of Pu^{3+}, Pu^{4+}, Pu^{6+}, and colloidal plutonium is described. TBP was used as the stationary phase and elution was carried out with 0.3 to 1.0 M HNO_3. (auth)

8880 (NYO-2523) FOAM SEPARATION IN ISOTOPE RECOVERY. Quarterly Report No. 2 for October 1, 1960 to December 31, 1960. (Radiation Applications Inc., Long Island City, N. Y.). Jan. 31, 1961. 13p. Contract AT(30-1)-2384.

A second group of foaming agents was tested for solubility, conductivity, foamability, and enrichment. Test results are tabulated. Surfactants were used in enrichment tests at pH 1 and 12 with metal ions Cs^{+}, Sr^{++}, Ce^{+++}, using as tracers Cs^{137}, Sr^{85}, and Ce^{141}. In experimental work, methods for removal of cesium were quantitatively examined. In one such method, $K_4Co_{10}(Fe(Cw)_6)_6$ is used as a carrier to absorb cesium from solution. Using tracer techniques, a 97.44% cesium removal was determined. Another method was tested in which an ion exchange resin and a foaming agent were used. A sulfonated polystyrene type resin removed 81.8% cesium in one test; however, it was not effective in the presence of sodium nitrate. A nuclear sulfonic acid cation exchanger was used in the presence of sodium nitrate for cesium removal. In one test a 36.2% removal was determined. (For preceding period see NYO-2522.) (J.R.D.)

8881 (TID-6501) A STUDY OF EQUILIBRIA INVOLVED BETWEEN DAREX OFF-GASES AND SOLUTIONS. Final Technical Report. Project No. A-427. Clyde Orr, Jr., Margaret C. Kordecki, and Clyde T. Young (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). July 31, 1960. 51p. Contract W-7405-ENG-26. Subcontract No. 1373.

A method for the quantitative analysis of aqua regia off-gases by combined spectrophotometric and chromatographic techniques was developed and used to analyze aqua regia off-gases. The percentages of nitrous oxide, nitric oxide, nitrogen dioxide, nitrosyl chloride, and hydrogen chloride were obtained by measuring the infrared transmission of the gaseous sample in a 10-cm cell with silver chloride windows. The wavelengths found to be appropriate for these gases were 2.888, 5.234, 3.228, and 6.119, 4.725, and 3.556 μ, respectively. The chlorine fraction was determined in carbon tetrachloride solution at 335 mμ by visible-region spectrophotometry after an aliquot of gas had been shaken with saturated sodium sulfate solution to dissolve the other gases that absorb visible light. An additional gas sample was bubbled through water to remove the soluble gases and was then analyzed for hydrogen, nitrogen, and oxygen by

gas chromatography on a molecular sieve column. Efforts were concentrated on analyzing the off-gases from 5M nitric acid : 2M hydrochloric acid and 2M nitric acid : 5M hydrochloric acid (the aqua regia concentrations used at Oak Ridge) boiling at no reflux, at high reflux, and when 304 stainless steel was being dissolved in them. The off-gases from the two aqua regia compositions alone consisted essentially of nitrosyl chloride, water, and chlorine. When stainless steel was dissolved in these acids, hydrogen, nitric oxide, nitrous oxide, nitrogen, and nitrogen dioxide were also evolved. The concentration of hydrogen was found to be considerably higher in off-gases from the 2M nitric acid : 5M hydrochloric acid mixture than in off-gases from the 5M nitric acid : 2M hydrochloric acid mixture (0.9 to 8.6% as opposed to 0.2 to 0.5%). The yield of hydrogen per gram of steel was 0.002 g for the 2 : 5 aqua regia and only 0.0001 g for the 5 : 2 aqua regia. (auth)

8882 (TID-11510) FINAL REPORT [FOR] PERIOD COVERED JULY 1, 1957–DECEMBER 31, 1957. J. Larsen, R. Barth, N. Sweet, and J. Carter (Carter Labs., Inc., Pasadena, Calif.). May 16, 1958. 40p. For Oak Ridge National Lab. Subcontract No. 992.

Work is reported on the development of equipment for electrolytic dissolution of spent nuclear fuel elements. A basic equipment design was developed, suitable for either stainless steel or zirconium-base fuel elements. Complete dissolution can be accomplished in the equipment regardless of size, shape, or fragmentation during the dissolution process. The equipment can be operated continuously and remotely. The process operates on either d-c or a-c current with high current efficiency, and depending on operating conditions, at a reasonably good energy efficiency. (W.L.H.)

8883 (TID-11612) THE SEPARATION OF SOME OF THE RADIOACTIVE FISSION PRODUCTS BY ELECTRODIALYSIS. II. THE ELECTROLYTIC MIGRATION OF CESIUM–BARIUM^{137}, CERIUM–PRASEODYMIUM^{144} AND ZIRCONIUM–NIOBIUM^{95} FROM ACID SOLUTIONS BY MEANS OF ION EXCHANGE MEMBRANES. Progress Report, January 15, 1960–December 1, 1960. G. J. Bub, C. W. Brauer, J. D. Vie, and W. H. Webb (Missouri School of Mines and Metallurgy, Rolla). 27p. Contract AT(11-1)-770.

The Cs^+ and Ba^{2+} ions transferred to the cathode cell from the feed cell at lower (1.0 to 0.5N) concentrations of HNO_3. It was shown that the transfer rate at the lower acidities has little dependency upon feed cell acidity. Graphical representations are given of results on the electrodialysis of Ce–Pr^{144} in HNO_3 solutions. Less transfer was observed from HF for Ce–Pr^{144}, which may be attributed to the colloidal CeF_3 formation. Zr–Nb^{95} transfers to the anode cell at a relatively slow rate and incompletely at low (0.5 to 0.25N) HNO_3 concentrations. A faster and more complete transfer occurs in oxalic acid at 1.0 to 0.5N. The best transfer rates were obtained in 1.0 to 0.5N HF. The results are tabulated for 2N HF showing the relative percent of initial isotope activity in the cells. (B.O.G.)

8884 (UCRL-Trans-603(L) ON ETHER-EXTRACTION OF FLUORIDES OR HYDROFLUORIC ACID SOLUTIONS OF VARIOUS ELEMENTS. Saburo Kitahara. Translated from Kagaku Kenkyusho Hôkoku 25(4-5), 165-7(1950). 6p.

Attempts were made to separate various fluorides and HF solutions of various elements with ether. From an HF solution of the fluoride, Sn(II) and Sn(IV) were completely extracted, and 62.2% As, 0.4% Sb, 3.1% Se, and 9.7% Mo were extracted. (C.J.G.)

8885 THE EXTRACTION OF URANIUM(VI) WITH DBP IN THE PRESENCE OF TBP. THE "SYNERGIC" EFFECT: SUBSTITUTION OR ADDITION? David Dyrssen and Libor Kuča (Royal Inst. of Tech., Stockholm). Acta Chem. Scand., 14: 1945-56(1960). (In English)

The nature of the mixed complexes, $UO_2A_2(HA)_xB_y$, of the uranyl ion with di-n-butyl phosphate (DBP = HA) and tri-n-butyl phosphate (TBP = B) in carbon tetrachloride was investigated at 25°C by measuring the distribution ratio q of U^{233} between carbon tetrachloride and 0.1M sulfuric acid. At concentrations of DBP between 0.0003 and 0.06M, and of TBP between 0 and 0.1M, two complexes are formed, namely $UO_2A_2(HA)_2$ at low $[B]_{org}[HA]^{-1}_{org}$ and $UO_2A_2(HA)B$ at high $[B]_{org}[HA]^{-1}_{org}$. The value obtained for the equilibrium constant of the following reaction in carbon tetrachloride $UO_2A_2(HA)_2 + B \rightleftharpoons UO_2A_2(HA)B + HA$ is $\log K^{-1}_{20} K_{11} = -3.0 \pm 0.2$. The concentrations of free HA and B were calculated from data of Dyrssen and Liem. It may thus be stated that in the present case the "synergic" effect is due to substitution rather than addition. (auth)

8886 LIQUID-LIQUID EXTRACTION OF VANADIUM(V) WITH TRIBUTYL PHOSPHATE. Santosh K. Majumdar and Anil K. De (Jadavpur Univ., Calcutta). Anal. Chem., 33: 297-9(Feb. 1961).

A fast and selective procedure is presented for the determination of vanadium after extraction with tributyl phosphate. Almost quantitative extraction of vanadium was achieved from hydrochloric acid ≥5M by a 5-min equilibration with TBP (100%). The effects of TBP concentration, salting-out agent, and diverse ions were investigated. Vanadium can be readily extracted in presence of Cu(II), Hg(II), Co(II), Ni(II), Ba(II), Bi(III), Fe(III), Cr(III), Th(IV), U(VI), Mo(VI), phosphate, and EDTA. The extractable species is $VOCl_3.2$ TBP. (auth)

8887 USE OF BASIC SILICA GEL FOR THE ELIMINATION OF Cs^{137} AND Sr^{90} FROM AQUEOUS SOLUTIONS. Giuseppe Cetini, Olimpia Gambino, and Franco Ricca. Atti accad. sci. Torino. I. Classe sci. fis., mat. e nat., 94: 950-69(1959-60). (In Italian)

The adsorbent properties of silica gel for Cs^{137} and Sr^{90} were studied with particular respect to the effects of concentration and the presence of other cations. The possibility of acid elution of the adsorbed cations was investigated. The advantages of the transformation of the silica gel into a vitreous mass capable of permanently retaining the adsorbed cesium and strontium were shown. (tr-auth)

8888 SEPARATION OF RADIOACTIVE ARSENIC FROM GERMANIUM IRRADIATED WITH PROTONS. Kazuo Saito (Univ. of Tokyo, Japan), Shigerô Ikeda, and Makoto Saito. Bull Chem. Soc. Japan, 33: 884-7(July 1960). (In English)

Elementary germanium and germanium dioxide were irradiated with protons of energies 10 to 14 Mev. The irradiated sample was dissolved in aqua regia and germanium tetrachloride was distilled in a current of chlorine with the addition of hydrochloric acid until the residue volume was < 1 ml. The chlorine was removed from the residue in a current of nitrogen and the arsenic trichloride was distilled in the presence of HCl and HBr. The total recovery from the distillation was 94%, with the major portion found in the first few milliliters of the distillate. The arsenic was then extracted from the distillate with CCl_4 in the presence of diethyldithiocarbamate. The results of the extraction are plotted as the counting rate of the aqueous phase as a function of repetition of extraction. The curves indicate that the extraction depends largely on the amount of reagent present.

Following a decay period of one week the remaining radioactivity consists of 17.5-day As^{74} and 76-day As^{73}. (B.O.G.)

8889 ON THE MECHANISM OF THE EXTRACTION OF URANYL NITRATE BY TRIBUTYL PHOSPHATE. II. INFRARED STUDY. Kenkichi Nukada (Government Chemical Research Inst. of Tokyo, Japan), Keiji Naito, and Utako Maeda. Bull. Chem. Soc. Japan, 33: 894-8(July 1960). (In English)

Results are given of an infrared study of the mechanisms involved in TBP extraction processes. Discussions are given for the systems: TBP-water, TBP-nitric acid, TBP-uranyl nitrate, and TBP-uranyl nitrate-nitric acid. Infrared spectra are given for each system. In the TBP-uranyl nitrate-nitric acid system, the infrared spectra of the replacement of nitric acid by uranyl nitrate and the replacement of uranyl nitrate by nitric acid were observed to determine the mechanism of extraction which gave a peak in the extraction curve at a HNO_3 concentration of 5 to 6 mole/liter. (B.O.G.)

8890 RADIOACTIVE PARENT-DAUGHTER SEPARATIONS. William J. Mayer and Robert L. Anderson (General Motors Corp., Warren, Mich.). Ind. Eng. Chem., 52: 993-4(Dec. 1960).

An experimental laboratory milker to produce In^{113m} (1.7 hr, 0.393 Mev γ activity) from Sn^{113} (112 days) was investigated. The In^{113m} is separated from Sn^{113} by Dowex 1 resin on an ion exchange column. Preliminary results indicate that In^{113m} can be separated from the parent by approximately one part per thousand to five parts in ten thousand. To augment the use of the indicator isotope In^{113m}, it was necessary to convert it to an organic soluble form. It was found that In^{113m} could be extracted from the eluate of the ion exchange column with thenoyltrifluoroacetone in benzene. (auth)

8891 A NEW PRODUCTION PROCESS FOR TELLURIUM-132. J. D. Eakins, J. Robson, and H. F. Stockley (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Intern. J. Appl. Radiation and Isotopes, 9: 124-6 (Dec. 1960). (In English)

Irradiated uranium was found to evolve H_2Te when dissolved in HCl, and this reaction was made the basis of a rapid and simple method of separating Te^{132} from most fission products. In this method, ~6M HCl and tellurous acid carrier are added continuously to the uranium sample, and the evolved H_2Te gas is swept away by nitrogen or helium into a solution of 5% $FeCl_3$ in ~3M HCl. Metallic tellurium is precipitated from this solution by addition of $SnCl_2$ solution, washed with ~5M HCl and water, and converted into the desired chemical form. The efficiency of separation and absorption of Te^{132} as H_2Te is >95%, and the over-all yield of Te^{132} as sodium telluride solution is >90%. An apparatus for effecting this method is described which is capable of separating 200 mc of Te^{132} per week. (D.L.C.)

8892 TRACER-CHEMICAL ISOLATION OF URANIUM-233 FROM IRRADIATED THORIUM BY SOLVENT EXTRACTION WITH TRIBUTYL PHOSPHINE OXIDE. A Preliminary Preparation of Uranium-233 with JRR-1. Tomitaro Ishimori, Kenju Watanabe, and Kan Kimura (Atomic Energy Research Inst., Tokyo). J. Atomic Energy Soc. Japan, 2: 750-7(Dec. 1960). (In English)

A small amount of U^{233} was isolated from thorium dioxide irradiated in JRR-1 by the solvent extraction method with (TBPO) in toluene. Irradiation was carried out for 173 hr at the neutron flux of 10^{11} neutrons/cm^2/sec. After cooling for about 5 months, the irradiated target was dissolved in hydrochloric acid containing a small quantity of potassium fluoride. The resultant solution was contacted with 1% TBPO-toluene solution. U^{233} and Pa^{233} were extracted into the organic phase while thorium remained in the aqueous phase. Most of the Pa^{233} extracted into the organic phase was removed by scrubbing with hydrochloric acid containing sodium fluoride. U^{233} remaining in the organic phase was stripped with acetic acid solution. After converting the acetic solution into 0.1N hydrochloric acid solution, U^{233} was finally purified by a cation exchange method. Radiochemical purity of U^{233} obtained was checked by the measurements of α energy. According to the solvent extraction behavior in the system of 1% TBPO-hydrochloric acid, it is proved that U^{233} obtained is in a state of UO_2^{2+}. (auth)

8893 PYROMETALLURGICAL PROCESSING OF NUCLEAR FUELS. Masayoshi Kanno (Tokyo Univ.). J. Atomic Energy Soc. Japan, 2: 767-78(Dec. 1960). (In Japanese)

Development of pyrometallurgical processing of irradiated nuclear fuels has been under way for several years. Interest in various processes has grown because they may serve as an aid to reduce fuel processing costs through the possibility of handling shortcooled fuels as well as the elimination of chemical conversions. Information is reviewed on melt refining, liquid-metal and salt processes, fractional crystallization, and electrolytic purification. The application of pyrometallurgical techniques to ceramic fuels is mentioned also. (auth)

8894 DISTRIBUTION OF SOME METAL IONS IN THE SYSTEM OF BIS(2-ETHYLHEXYL)-ORTHOPHOSPHORIC ACID VS. NITRIC–OXALIC ACID SOLUTION. Kan Kimura (Japan Atomic Energy Res. Inst.). J. At. Energy Soc. Japan, 2: 585-90(1960). (In English)

The change in Kd values caused by the addition of oxalic acid to the system of bis(2-ethylhexyl)-orthophosphoric acid (HDEHP) and nitric acid is presented. The Kd values for zirconium and protactinium decreased noticeably after addition of small amounts of oxalic acid. On the other hand, the Kd values for uranium remained high. Uranium was recovered from the irradiated uranium solution by this nitric-oxalic acid method. The uranium fraction contained much less γ-contaminants than that obtained by the usual HDEHP extraction. The decontamination factor for Zr^{95} and Nb^{95} became a thousand times higher than that of the usual HDEHP extraction. (auth)

8895 EXTRACTION OF PLUTONIUM FROM URANIUM BY LIQUID MAGNESIUM. M. W. Nathans, E. Greenberg, and H. M. Feder (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 9: 32-4(Jan. 1961).

The partition of plutonium between liquid magnesium and uranium or uranium-chromium alloy was investigated. The extraction was found to be reversible and essentially independent of concentration up to 1 wt.% plutonium. The molar partition coefficients for both systems can be expressed as a function of temperature by the equation $\log K = 1887/T - 2.010$. (auth)

8896 THE MELT REFINING OF IRRADIATED URANIUM: APPLICATION TO EBR-II FAST REACTOR FUEL. VI. THE BEHAVIOR OF PLUTONIUM IN THE MELT-REFINING PROCESS. V. G. Trice, Jr. and N. R. Chellew (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 9: 55-8(Jan. 1961).

The behavior of plutonium in melt refining of plutonium-bearing uranium alloys was studied as functions of the initial plutonium concentration in the charge, time, and temperature of refining and the carbon impurity added to the charge. Under all conditions studied, the percentage recovery of plutonium in the purified metal was slightly lower than that of uranium. The concentration of plutonium in uranium-20 wt.% plutonium-10 wt.% fission alloy (EBR-II

type fuel) melt refined for 3 hr at 1300 or 1400°C was 0.31 ± 0.23% lower than the plutonium concentration in metal charged to the process. (auth)

8897 THE MELT REFINING OF IRRADIATED URANIUM: APPLICATION TO EBR-II FAST REACTOR FUEL. VII. THE EVOLUTION OF XENON AND KRYPTON. A. Schneider and N. R. Chellew (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 9: 59-63(Jan. 1961).

The release of the fission gases, xenon and krypton, from molten irradiated uranium was studied experimentally at total initial gas contents of 0.002 to 138 ppm. At concentration levels anticipated in spent EBR-II fuels, over 99% of the xenon and krypton is expected to be removed from the molten metal. (auth)

8898 THE MELT REFINING OF IRRADIATED URANIUM: APPLICATION TO EBR-II FAST REACTOR FUEL. VIII. THE BEHAVIOR OF RARE EARTHS, YTTRIUM, BARIUM, STRONTIUM, AND CESIUM. N. R. Chellew, G. A. Bennett, and V. G. Trice (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 9: 64-70(Jan. 1961).

Melt refining of synthetic EBR-II alloy in oxide crucibles at temperatures between 1200 and 1400°C under an inert atmosphere resulted in a separation of rare-earth elements, yttrium, and alkaline-earth elements from ingot fractions. The rate of cerium removal is shown to behave as a first-order reaction. Cesium is quantitatively volatilized from highly irradiated uranium fuels refined at 1200°C for 4 hr. (auth)

8899 THE MELT REFINING OF IRRADIATED URANIUM: APPLICATION TO EBR-II FAST REACTOR FUEL. IX. SORPTION AND RETENTION OF SODIUM AND CESIUM VAPOR ON STATIONARY BEDS AT ELEVATED TEMPERATURE. J. Wolkoff and A. A. Chilenskas (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 9: 71-7 (Jan. 1961).

Materials capable of trapping alkali metal vapors at temperatures up to 800°C were tested and a number of surface-active materials proved efficient. A sufficient quantity of molecular sieves, activated alumina, or activated carbon can be contained in a crucible cover to trap and hold the evolved alkali metal vapors from an EBR-II melt refining furnace charge of 10 kg. The cover design is under development. (auth)

8900 THE MELT REFINING OF IRRADIATED URANIUM: APPLICATION TO EBR-II FAST REACTOR FUEL. X. THE BEHAVIOR OF ZIRCONIUM. N. R. Chellew and V. G. Trice (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 9: 78-81(Jan. 1961).

Melt refining experiments in which irradiated uranium or synthetic EBR-II alloys were melted in oxide crucibles showed that removal of zirconium as an oxide does not occur at temperatures up to 1400°C. Removal of zirconium by carbon scavenging of the melt was approximately 50% in 5-hr melts at 1400°C; the mechanism and products of reactions which led to this separation are discussed. Zirconium contamination of uranium–cerium alloys melted in lime-stabilized zirconia crucibles was negligible. (auth)

8901 THE MELT REFINING OF IRRADIATED URANIUM: APPLICATION TO EBR-II FAST REACTOR FUEL. XI. BEHAVIOR OF IODINE IN MELT REFINING. N. R. Chellew and M. Ader (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 9: 82-6(Jan. 1961).

Melt refining of synthetic EBR-II alloy in stabilized zirconia crucibles at 1400°C for 3 hr under one atmosphere of helium pressure resulted in almost complete volatilization of iodine from ingot and skull fractions. Removal of iodine was strongly dependent on refining temperature. Volatilized products were primarily iodides of metals initially present as minor oxide constituents of the crucible; no evidence for evaporation as free iodine was found in the melt refining operation. (auth)

8902 THE MELT REFINING OF IRRADIATED URANIUM: APPLICATION OF EBR-II FAST REACTOR FUEL. XII. THE BEHAVIOR OF RUTHENIUM, MOLYBDENUM, PALLADIUM, RHODIUM, TECHNETIUM, ANTIMONY, CADMIUM, AND TELLURIUM. N. R. Chellew and G. A. Bennett (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 9: 87-90(Jan. 1961).

Ruthenium, molybdenum, palladium, rhodium, technetium, and antimony are retained by the bulk metal when uranium containing macrolevels of accompanying fission elements is melt-refined in oxide crucibles at 1200 to 1400°C. Under similar conditions, cadmium and tellurium are nearly quantitatively removed, the latter element by a proposed mechanism involving the formation of a stable compound with cerium. (auth)

8903 THE SEPARATION OF URANIUM AND RARE EARTHS ELEMENTS FROM ETHYLENEDIAMINETETRAACETIC ACID-SOLUTIONS ON ION-EXCHANGE RESINS. Irena Krawczyk (Nuclear Research Inst., Warsaw). Nukleonika, 5: 649-59(1960). (In Polish)

A method of analytical separation of traces of rare-earth elements (on order of 10^{-5} g and less) from uranium was elaborated. The solution containing uranium, rare earths, and disodium salt of ethylenediaminetetraacetic acid is passed through a column with cation-exchange resin Amberlite IRC-50 in sodium form. Uranium is adsorbed on the ion-exchange resin (rare earths pass into an effluent). The order of magnitude of the error with regard to the separation of rare earths is estimated as several per cent. (auth)

8904 INVESTIGATIONS OF THE SORPTION OF URANIUM ON PEATS. Zbigniew Rozmej, Stanisław Rubiński, and Zbigniew Uruski (Politechnika Gdanska, Danzig). Nukleonika, 5: 661-70(1960). (In Polish)

The sorption qualities of peats were investigated in relation to ion UO_2^{2+} for the dependence of: kind of peat, acidity of solution, uranyl ion, and manner of preparation of the peat. In this investigation, solutions containing 1 g/l uranium were used. It was affirmed that sorption of the ion UO_2^{2+} in grams of uranium in 100 g of dry peats-mass amounted to 22.2%. It was also confirmed that peats can be used by removal of vestiges of uranium in water solutions. (auth)

8905 SEPARATION OF THE VARIOUS OXIDATION STATES OF PLUTONIUM BY REVERSED-PHASE PARTITION CHROMATOGRAPHY. Rajmund Gwóźdź and Sławomir Siekierski (Inst. of Nuclear Research, Polish Academy of Science, Warsaw). Nukleonika, 5: 671-6(1960). (In English)

The application of reversed-phase partition chromatography to the separation and determination of Pu(III), Pu(IV), Pu(VI), and colloidal plutonium was described. Tributyl phosphate was used as the stationary phase and elution was carried out with 0.3 to 1.0M HNO_3. (auth)

8906 EXTRACTION OF RARE EARTH ELEMENTS BY DI- AND TRIBUTYL PHOSPHATES. E. E. Kriss and Z. A. Sheka. Zhur. Neorg. Khim., 5: 2819-23(Dec. 1960). (In Russian)

Distribution coefficients for lanthanum, neodymium, yttrium, and ytterbium nitrate extraction by di- and tributyl phosphate were compared, and their relation to the concentration of nitric acid and nitrates in aqueous solu-

tion was determined. In DBP extraction an increase of nitric acid concentration and of rare-earth nitrates diminishes the distribution coefficients while in TBP extraction distribution coefficients increase with the increase of rare-earth nitrate concentration. The distribution coefficients are always higher in DBP extraction than in TBP. DBP extraction at low acidity achieves better separation of rare earths than TBP; at high acidity the difference is much smaller. (R.V.J.)

8907 BEHAVIOR OF HEXAVALENT AND TRIVALENT CHROMIUM IN URANYL AND PLUTONIUM NITRATE EXTRACTION BY TRIBUTYL PHOSPHATE SOLUTIONS. V. B. Shevchenko, I. V. Shilin, and Yu. F. Zhdanov. Zhur. Neorg. Khim., 5: 2832-40(Dec. 1960). (In Russian)

Extraction of chromium(VI) was achieved by tributyl phosphate. An analysis indicated an increase of the Cr^{6+} distribution coefficient with increased TBP concentration. An increase in aluminum and sodium nitrates reduced the distribution coefficient. Data on Cr^{6+} TBP extraction show a solvation number of 3. An analysis of the dependence of the Cr^{6+} distribution coefficient on concentration and pH shows that Cr^{6+} is extracted as chromic acid. The concentration of uranyl nitrate up to 1 mole/liter does not influence the Cr^{6+} distribution coefficient. With larger uranyl nitrate concentrations, the Cr^{6+} distribution coefficient diminishes. The distribution coefficients were calculated for organic and aqueous phases: $[(H_2CrO_4 \cdot 3T)_0/(H_2CrO_4)_{aq}\ T_0^3] = K_4 = 0.535$, $[(H^+)_{aq}(HCrO_4^-)_{aq}/(H_2CrO_4)_{aq}] = K_3 = 1.26$. K_3 is in good agreement with published literature. TBP extraction of trivalent chromium is very poor. (R.V.J.)

8908 CHROMATOGRAPHIC SEPARATION OF ZIRCONIUM AND HAFNIUM. I. N. Marov, V. K. Belyaeva, A. N. Ermakov, and D. I. Ryabchikov (Vernodskiĭ Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Zhur. Neorg. Khim., 5: 2844-7(Dec. 1960). (In Russian)

Hafnium and zirconium separation by ion exchange and desorption by 0.025M acetic acid and 1M perchloric or nitric acid is described. The influence of the mineral acid on the V_{max} position and separation efficiency is analyzed. The influence is related to an imposed second process, complex formation with the mineral acids. The strength of zirconium and hafnium complexes with mineral acids diminished according to the sequence: $H_2SO_4 \gg HCl > HNO_3$. It was also found that with increased ion exchange load the V_{max} increased and the ratio V_{max} Hf/V_{max} Zr diminished. It is postulated that the latter is related to the appearance of poly-zirconium compounds and to the effects of large quantities of zirconium on the chemical behavior of hafnium. (R.V.J.)

8909 THE ACCEPTOR-DONOR CONCEPTS IN EXTRACTION. A. V. Nikolaev, N. M. Sinitsyn, and S. M. Shubins (Inst. of Inorganic Chemistry, Academy of Sciences, U.S.S.R.). Zhur. Strukt, Khim., 1: 319-23(Sept.-Oct. 1960). (In Russian)

The structure of organic extractants for extracting inorganic substances from water solutions was analyzed on the basis of acceptor-donor concepts, induction effects, experimental data on extracting efficiency, strength of molecular bonds, etc. Special attention was given to the polarity of the organic molecule, the method for changing its magnitude, and to the presence of extractants with high and low polarity values. (tr-auth)

8910 REACTOR FUEL PROCESSING. Technical Progress Review, Vol. 3, No. 4. Stephen Lawroski, ed. (Argonne National Lab., Ill.). Oct. 1960. 97p.

Current information on the following subjects is reported: commercial aspects of fuel processing; safety in chemical processing; preparation for fuel processing; research and development on fuel processing; waste disposal; and production of uranium, thorium, plutonium, and their compounds. (W.L.H.)

8911 RECOVERY OF URANIUM, ALUMINIUM AND IRON VALUES. (to United States Atomic Energy Commission). British Patent 855,811. Dec. 7, 1960.

A method is outlined for recovering and separating uranium, aluminum, and iron from ores having relatively large quantities of iron and aluminum as compared with the amount of uranium present. This method, especially applicable to separating uranium from Chattanooga shale, consists of chlorinating the ore at 600 to 1000°C to form volatile metal chlorides, condensing at 100 to 300°C to remove the sulfur and revaporizing, passing the volatile chlorides into granular Al_2O_3 at 600 to 1000°C to deposit the uranium, passing the remaining chlorides into Fe_2O_3 at 400 to 700°C to convert the aluminum into Al_2O_3 and oxidizing the remaining iron to form Fe_2O_3. The chlorine left over is recycled. The uranium in the Al_2O_3 bed may be recovered by known means. (D.L.C.)

8912 IMPROVEMENTS IN OR RELATING TO SEPARATION OF URANIUM AND PLUTONIUM. (to United Kingdom Atomic Energy Authority). British Patent 855,853. Dec. 7, 1960.

A method for separating plutonium and uranium from each other in irradiated uranium is outlined which uses the volatility of UF_6. In this method, the metals or dry compounds of the metals are treated with BrF_3 or ClF_3 in presence of a compound of arsenic, antimony, or bismuth, and the resulting UF_6 vapors are collected. Fission products, which may respond differently to the fluorination, may be removed from the UF_6 condensate or the plutonium residue by known means. (D.L.C.)

8913 METHOD OF SEPARATING ELEMENTS, e.g., RADIOACTIVE ELEMENTS, ISOTOPES, ANIONS, CATIONS, ETC., BY ADSORPTION. (to Centre d'Études pour les Applications de l'Énergie Nucleaire). French Patent 1,186,041. Feb. 16, 1959.

Utilization of sawdust as adsorbent for the recovery of elements from solutions is described. By establishing the right pH conditions selective adsorption can be effected; thus Hf can be separated from Sr, Cs, Zr and Nb, and cations from anions. After adsorption the column is selectively eluted, or it is incinerated and the ash selectively eluted. (NPO)

8914 METHOD FOR SEPARATING PROTACTINIUM, THORIUM AND URANIUM FROM NEUTRON IRRADIATED THORIUM. (to U. S. Atomic Energy Commission). French Patent 1,188,528. Mar. 16, 1959.

One volume of a nitric acid solution of neutron-irradiated thorium containing 13 m/ HNO_3, 1.5 m/l Th nitrate, 0.5 m/l Al nitrate, 0.04 m/l F ions, and 0.003 m/l Hg ions and being 0.3N deficient in nitrate ions, is countercurrently extracted with 5 volumes of a solution consisting of 42 vol.% TBP and 58 vol.% saturated hydrocarbon. The organic phase thus obtained is washed with 1 volume of an aqueous 0.5 m/l aluminum nitrate solution, which is 0.3N deficient in nitrate ions and contains 0.003 m/l phosphate ions. The composition of the combined aqueous phases, containing palladium and fission products, is adjusted to 2.5 m/l aluminum nitrate, 1.3N nitrate ion deficiency, and 0.3 m/l chromate ion; the resultant coprecipitate of aluminum chromate and palladium is separated from the liquid containing the fission products. The precipitate can be

stocked as a source of pure U^{233}; alternatively palladium can be extracted from it. The 5 volumes of the organic phase, containing thorium and uranium, are extracted with 6 volumes 0.2N aqueous nitric acid; the aqueous extract is washed out with 1 volume TBP extractant. The resulting aqueous phase contains thorium while the uranium is left in the organic phase. It can be recovered by extracting 6 volumes of this phase with 3 volumes 0.05M aqueous nitric acid and contacting the aqueous solution with a cation exchanger. (NPO)

8915 METHOD OF TREATING NUCLEAR FUELS. (to United Kingdom Atomic Energy Authority). French Patent 1,207,293. Aug. 31, 1959.

Fissile or fertile metal oxides can be recovered from their dispersions in a ferrous metal by melting the metal in an inert atmosphere, keeping the metal in the molten state until a substantial part of the oxide(s) floats on the surface, and then mechanically separating the oxide from the metal. UO_2 can thus be separated from iron in a yield of 90%. (NPO)

8916 ANION EXCHANGE METHOD. (to United Kingdom Atomic Energy Authority). French Patent 1,217,492. Dec. 7, 1959.

Uranium is recovered from aqueous solutions or slurries by passing the medium in turbulent flow over the interior and/or exterior surface of a tubular anion exchanger. Preferably the anion exchanger tubes are obtained from tubular polyvinyl chloride polymers by replacing the chloride atoms by ammoni-groups. (NPO)

8917 CESIUM RECOVERY FROM AQUEOUS SOLUTIONS. Charles A. Goodhall (to U. S. Atomic Energy Commission). U. S. Patent 2,952,640. Sept. 13, 1960.

A process for recovering cesium from aqueous solutions is given in which precipitation on zinc ferricyanide is used. The precipitation is preferably carried out in solutions containing at least 0.0004M zinc ferricyanide, an acidity ranging from 0.2N mineral acid to 0.61N acid deficiency, and 1 to 2.5M aluminum nitrate. (D.L.C.)

8918 SEPARATION OF GASES BY DIFFUSION. R. E. Peierls, F. E. Simon, and H. S. Arms (to U. S. Atomic Energy Commission). U. S. Patent 2,964,124. Dec. 13, 1960.

An apparatus is described for the separation of mixtures of gaseous or vaporous media by diffusion through a permeable membrane. The apparatus consists principally of a housing member having an elongated internal chamber dissected longitudinally by a permeable membrane. Means are provided for producing a pressure difference between opposite sides of the membrane to cause a flow of the media in the chamber therethrough. This pressure difference is alternated between opposite sides of the membrane to produce an oscillating flow through the membrane. Additional means is provided for producing flow parallel to the membrane in opposite directions on the two sides thereof and of the same frequency and in phase with the alternating pressure difference. The lighter molecules diffuse through the membrane more readily than the heavier molecules and the parallel flow effects a net transport of the lighter molecules in one direction and the heavier molecules in the opposite direction within the chamber. By these means a concentration gradient along the chamber is established. (auth)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

8919 (ANL-6199(p.119-32)) CONVECTIVE TURBULENCE WIND TUNNEL PROJECT. G. H. Strom and E. J. Kaplin.

Progress is reported in wind-tunnel experiments on smoke diffusion. Modifications in experimental apparatus are described. Data are tabulated from diffusion tests. It was concluded that convective turbulence significant to smoke-plume diffusion can be obtained in scale-model wind-tunnel experiments with proper use of thermal and mechanical boundary controls. (C.H.)

8920 (CF-59-11-130) UNDERWATER ELECTRIC ARC CUTTING MANIPULATOR FOR HRT SCREEN REMOVAL. P. P. Holz (Oak Ridge National Lab., Tenn.). Nov. 26, 1959. 47p.

A manipulator system, incorporating a simplified heli-arc underwater cutting torch, was designed, developed, and tested to perform the following remote functions: enter through the existing 2-in. HRT core access opening; pick up and transfer screens from the horizontal to a vertical position; latch and firmly clamp a screen against the manipulator mast; move a torch to permit the cutting of screen strips of predetermined width; and provide electrical signals to determine effectiveness of cutting. Detailed descriptions of equipment and manipulator operating specifications and procedures are included. (auth)

8921 (GAMD-1830) PARAMETER STUDY—CYLINDER WITH PISTON. C. Riparbelli (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nov. 16, 1960. 29p. Contract AF29(601)-2207.

A parameter study was made of the relative motion of a cylinder and a piston in free space. The piston is decelerated by the gas pressure while the cylinder is accelerated. The pressure-volume relation for the gas is assumed as polytropic with various exponents. The equation of motion is written in nondimensional form and is integrated from time zero to the time at which the relative velocity piston-cylinder vanishes. For each case considered the maximum relative displacement, the maximum pressure, and the duration, t_1, of the upstroke are given in terms of nondimensional parameters. The gas pressure is assumed to be uniform in the cylinder at any time. Therefore, the results are considered to be valid for velocities of the piston but small compared to the velocity of sound in the gas. The results of the computations are given in graphical and tabular forms. (B.O.G.)

8922 (HW-57089) FINAL REPORT-DESIGN TEST PR-25, SHROUD TUBE COLLAPSING PRESSURES AND INSTALLATION METHODS. R. L. Gruver (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 25, 1958. 17p. Contract AT(45-1)-1350.

A design test was made to determine the collapsing pressures of the PRTR shroud tubes, and to investigate methods of attaching the shroud tube to the bottom tube sheet of the colandria. The shroud tube samples were collapsed at temperatures from 400°F up to and including 700°F. The collapse pressures range from a minimum of 21 psig at 700°F to a maximum of 76 psig at 400°F. (W.L.H.)

8923 (HW-65937) DESIGN CRITERIA FOR FUEL DISSOLUTION SYSTEMS AND ASSOCIATED SERVICE FACILITIES. PLANT MODIFICATIONS FOR REPROCESSING NON-PRODUCTION REACTOR FUELS. PROJECT CGC-830. S. R. Bierman, W. A. Graf, M. Kass, G. Kligfield, R. W. McKee, L. F. Patridge, and R. G. Pitkin (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 29, 1960. 138p.

Design parameters are presented for phases of the facility to reprocess low-enrichment fuels from nonproduction reactors. Included are plant flowsheets and equipment layouts for fuel element dissolution, centrifugation, solution adjustment, and waste handling. Also included are the basic design criteria for the supporting facilities which service

these phases and all other facilities located in the vicinity of the selected building (Bldg. 221-U). (J.R.D.)

8924 (HW-67202) DYNAMIC DECONTAMINATION STUDIES: A SUMMARY OF ELMO-10 SCANNING TESTS WITH CONTAMINATED S1W BOILER TUBING. R. D. Weed (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 3, 1960. 11p. Contract AT-(45-1)-1350.

The most effective decontaminating process utilized alkaline permanganate and ammonium dibasic citrate–EDTA solutions. (J.R.D.)

8925 (KAPL-M-CH-1) REMOVAL OF GALLED CLOSURE NUT FROM L-42 LOOP IN-PILE ASSEMBLY–MTR REACTOR. C. W. Higby and M. L. Ballou (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 23, 1960. 8p. Contract W-31-109-Eng-52.

The threads of the L-42 closure nut were galled during loop charging to such an extent that a special technique employing a lubricant-abrasive mixture was necessary to separate the parts. The threads in the in-pile tube were dressed following nut removal and a new nut provided, restoring the loop to normal operation. The cause of the galling has not been established, however, it appears that damage to the threads during handling or inclusion of a foreign particle may have been responsible. (auth)

8926 (NAA-SR-Memo-5615) SPACE HANDBOOK TURBINES. [J.] Grimaldi (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 29, 1960. 5p.

Turbine specific weight vs. power plant output was investigated for rubidium, potassium, and sodium at several inlet temperatures to obtain order of magnitude performance and weight of possible nuclear power plant systems. (W.L.H.)

8927 (ORNL-2977) IN-PILE CORROSION TEST LOOPS FOR AQUEOUS HOMOGENEOUS REACTOR SOLUTIONS. H. C. Savage, G. H. Jenks, and E. G. Bohlmann (Oak Ridge National Lab., Tenn.). Dec. 21, 1960. 77p. Contract W-7405-eng-26.

An in-pile corrosion test loop is described which is used to study the effect of reactor radiation on the corrosion of materials of construction and the chemical stability of fuel solutions of interest to the Aqueous Homogeneous Reactor Program at ORNL. Aqueous solutions of uranyl sulfate are circulated in the loop by means of a 5-gpm canned-rotor pump, and the pump loop is designed for operation at temperatures to 300°C and pressures to 2000 psia while exposed to reactor radiation in beam-hole facilities of the LITR and ORR. Operation of the first loop in-pile was begun in October 1954, and since that time 17 other in-pile loop experiments were completed. Design criteria of the pump loop and its associated auxiliary equipment and instrumentation are described. In-pile operating procedures, safety features, and operating experience are presented. A cost summary of the design, fabrication, and installation of the loop and experimental facilities is also included. (auth)

8928 (S & T Memo-13/58 & Add.) THE BEHAVIOUR OF A THIN SHALLOW SPHERICAL CAP WITH A CENTRAL LOAD. D. G. Ashwell (University Coll. of South Wales and Monmouthshire, Cardiff). Sept. 1958. 42p.

The asymmetrical behavior of a thin uniform shallow spherical cap, simply-supported at its edge, and loaded with a central load parallel to its axis is investigated. The application of an increasing load caused a region of reversed curvature to spread from the center to the edge. The inner region and the remainder of the shell are each assumed to suffer small displacements from spherical surfaces, viz. the unstrained surface for the outer, and a surface of equal but reversed curvature for the inner. The loads applied were sufficient to cause the shell to snap through into its other possible unloaded-form (push-through), and were then reversed to snap it back again (push-back). Typical load-deflection curves are presented for push-through and for push-back. The maximum stresses in the shell in its reversed shape are presented as a function of r_2' (the radius of the shell) in terms of p′ (the membrane stresses). The energy released as the shell snaps through or back is presented as a function of r_2' in terms of U′ (energy stored in shell). (auth)

8929 (UCRL-6032) STRESSES AND DEFLECTION IN A CYLINDRICAL SHELL SUBJECTED TO CONCENTRATED RADIAL LOADS. Robert F. Steidel, Jr. and Maurice Galasso (California. Univ., Livermore. Lawrence Radiation Lab.). July 1960. 48p. Contract W-7405-eng-48.

The measured stresses and deflections of cylindrical shells with free ends, when subjected to concentrated loads along the central diameter, are presented. An empirical analogy is made with a simply supported flat plate for which stresses and deflection are easy to compute. Over the range of parameters studied (the ratio of cylinder diameter to wall thickness varied from 32 to 64, and the ratio of cylinder length to diameter varied from 0.6 to 5), the agreement is such that the empirical results should have useful application in the design of shells for local loading. (auth)

8930 A CRYOGENIC DEVICE FOR IRRADIATION IN LIQUID NITROGEN. L. Bochirol, J. Doulat, and L. Weil (Centre d'Etudes Nucleaires, Grenoble, France). Cryogenics, 1: 44-6(Sept. 1960).

A brief review of existing types of liquid nitrogen loops is given followed by a description of a loop operating according to a new principle for irradiation in a permanent liquid nitrogen bath. This extra-pure nitrogen contained in a small vessel is recondensed in ordinary liquid nitrogen at a certain distance from the core in a zone where the flux is weak, so as to eliminate any explosion hazards, and flows back into the bath under the action of gravity. The design of the apparatus is extremely simple and it is reliable in operation owing to the absence of mechanical circulating equipment. The consumption of nitrogen is quite small. The apparatus enables the samples to be taken out in a cold condition. It was operated satisfactorily for several continuous one-week periods. (auth)

8931 ABRASIVE CLEANING OF SHELL AND TUBE HEAT EXCHANGERS. R. F. Battistella, J. L. Powell, R. A. Yeakey, and S. Bernstein (Union Carbide Nuclear Co., Paducah, Ky.). Ind. Eng. Chem., 52: No. 12, 58A-61A(Dec. 1960).

During the course of the evaluation of recirculating water treatments for corrosion and scaling inhibition over the past 5 years, severe localized corrosion of the copper tubes causing pits filled with hard deposits and deposition of a soft phosphate scale were observed on the water side of the condensers. The pitting was arrested by recent improved water treatments, and several methods for scale removal were tried, which were considered as ineffective, too severe, or too tedious. A cleaning method was developed which consisted of pumping an abrasive slurry through the condenser tubes at moderate to high velocities to remove the soft scale by gentle, controlled, erosive action. The

abrasive particle sizes were −40 to +160 mesh sand in a concentration of 20% by volume in water, and circulated at velocities of 10 to 12 fps. The process proved to be extremely effective in the removal of soft scale, while slurry action on the hard deposits found in the pits removed only that portion which projected into the tube without disturbing the deposit recessed below the tube surface. A mobile unit was constructed which has been in satisfactory operation for the 3 years that it has been used to clean fouled condensers. A graphical representation is given showing the over-all heat-transfer coefficients as a function of water velocity for fouled and cleaned condensers. The basic equipment items and performance characteristics of the cleaning unit are given. (B.O.G.)

8932 A HIGH INTENSITY CESIUM-137 RESEARCH IRRADIATOR. R. C. Palmer and R. W. Carter (Georgia Inst. of Tech., Atlanta). Intern. J. Appl. Radiation and Isotopes, 9: 123-4(Dec. 1960). (In English)

A 12,000-c Cs^{137} research irradiator of the Notre Dame type was constructed at the Georgia Institute of Technology. The irradiator consists of a center tube with two circular arrays of 12 inner and 12 outer tubes around it. 1000-c Cs^{137} sources are disposed in the inner tubes, and samples for irradiation are inserted in the center and outer tubes. The dose rate is 1.4×10^6 rads/hr in the center tubes and 1×10^6 rads/hr in the outer tubes. A plot of the dose variance with vertical movement in the irradiation area is given. (D.L.C.)

8933 ENVIRONMENTAL IRRADIATION TEST FACILITY. A. H. Rose, Jr. and C. S. Brandt. J. Air Pollution Control Assoc., 10: 331-5(Aug. 1960).

Eye irritation, plant damage, reduction of visibility, and other related manifestations of urban air pollution are due in part to photochemical and secondary dark reactions in the atmosphere involving oxides of nitrogen, hydrocarbons, and other organic compounds. The natural atmospheric environment is a complex, highly reactive system and its simulation requires the duplication of the photochemical and secondary dark reactions involving organic and inorganic substances. Reproduction of such a system is discussed. An environmental irradiation test facility is composed of 5 major components: dynamometer unit, dilution air purification unit, exhaust dilution assembly, irradiation chambers, and the exposure facilities to evaluate air pollution effects of the irradiated pollutants. Source of air pollutant to be employed in the initial studies will be furnished by an automotive internal engine. (auth)

8934 THE AEROSOL EFFICIENCY AND PRESSURE DROP OF A FIBROUS FILTER AT REDUCED PRESSURES. S. C. Stern, H. W. Zeller, and A. I. Schekman (General Mills, Inc., Minneapolis, Minn.). J. Colloid Sci., 15: 546-62(Dec. 1960).

The collection efficiency of an Institute of Paper Chemistry fibrous filter for monodispersed aerosols of 0.026 μ to 1.71 μ diameter and the resistance to flow through the filter were investigated experimentally at reduced pressures which simulate air densities in the stratosphere. Single fiber efficiencies in the diffusion and impaction regimes were calculated and compared with theory. Resistance to flow through the mat was analyzed in terms of a drag coefficient of a single fiber imbedded in a mat or flow through a bed composed of capillary tubes. The experimental results show the dominant effects of slip flow in increasing collection efficiency and reducing pressure drop through the filter at reduced pressures. (auth)

8935 THERMOELECTRIC PUMPS FOR MOLTEN METALS. Dietrich Rex. VDI Zeitschrift, 103: 17-19 (Jan. 1961). (In German)

Thermoelectric pumps for molten metals are suitable for maintaining the operation of sodium-cooled reactors in the event of failure of the main pump or, in general, for pumping molten metals. The theoretical principles of such pumps are simple and they permit the essential operational data to be quickly estimated. A large sodium plant is above all intended to elucidate the influences of the dimensions, the flow pattern of the circulating metal, and the structure of the channel walls on the operation of thermoelectric pumps. (auth)

8936 IMPROVEMENTS RELATING TO ELECTROMAGNETICALLY-OPERATED GRABS. Keith William Morris (to Fairey Co., Ltd.). British Patent 859.112. Jan. 18, 1961.

An electromagnetically operated grab is designed for inserting and removing reactor fuel elements into and from the core fuel channels. The grab has a lock arranged to be operated by the movement of an armature in response to a magnetic field. (D.L.C.)

8937 METHOD AND APPARATUS FOR GAS SEPARATION. (to Aktiebolaget Atomenergi). French Patent 1,191,236. Apr. 6, 1959.

A gaseous diffusion process is offered in which the diffusion barrier is constituted by an Al_2O_3 foil, prepared by exhaustive anodic oxidation of a 0.007 to 0.050-mm-thick aluminum foil. The oxidation is effected at 20°C in 10% oxalic acid or 5 to 10% sulfonic acid, with alternating current (8 to 20 volts; 2 to 50 A/dm^2), giving an oxide foil with pores of about 2×10^{-5} mm diameter. The foil is washed with water and air dried at 500 to 550°C; the permeability is thereby increased and the average pore diameter decreased. Any remaining unoxidized aluminum can be removed with Cl_2 at 500 to 550°C. The permeability can be further increased by an after-treatment with 5 to 20% H_2SO_4 or 1 to 15% HCl solution. (NPO)

8938 DEVICE WITH A REMOVABLE ELEMENT, e.g., A FILTER ELEMENT, THROUGH WHICH A FLUID IS INTENDED TO FLOW. (to La Précision Mécanique). French Patent 1,191,456. Apr. 13, 1959.

A filter device for insertion in a coolant pipeline of gas-cooled reactors, incorporating a pleated paper filter element that by remote handling can either be brought into close contact with the inlet and outlet of the device or be discharged into a shielded container. (NPO)

8939 METHOD OF EARTH-MOVING BY MEANS OF NUCLEAR EXPLOSIONS. (to P.M.C.M.). French Patent 1,203,166. July 27, 1959.

It is proposed to create a subterranean tunnel by eroding a narrow passage between two shafts with the hot gases resulting from a nuclear explosion at the bottom of one of these shafts. The erosion can be intensified by previously filling said shaft with water, the explosion then producing superheated steam. By obstructing the free escape of the explosion gases, the ground above the tunnel is burst open. It is also proposed that the explosion gases or other properly chosen gases that have been heated by the explosion gases are made to circulate through passages in mineral deposits in order to extract said deposits or to effect chemical transformations such as reduction of iron ores or underground gasification. (NPO)

Heat Transfer and Fluid Flow

8940 (AFBMD-TR-60-180) UNSTEADY ABLATION. Research Report 94. Steven Georgiev (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Sept. 1959. 26p. Contract AF04(647)-278

The transient ablation process for nonradiating glassy materials is discussed, and numerical calculations are presented for quartz along an ICBM trajectory. It is shown that the transient effects do not appreciably affect the amount of ablated material along the trajectory but that they very significantly affect the amount of insulating material required after ablation ceases. The transient ablation analysis is also applied to quartz under arc wind-tunnel heating conditions, and it is shown that the experimentally obtained ablation history can be used to deduce the high-temperature thermal diffusivity of the ablating material. (auth)

8941 (ANL-6237) THE CALCULATION OF TRANSIENT TEMPERATURE DISTRIBUTIONS IN A SOLID CYLINDRICAL PIN, COOLED ON THE SURFACE. J. Heestand, D. F. Schoeberle, and L. B. Miller (Argonne National Lab., Ill.). Oct. 1960. 142p. Contract W-31-109-eng-38.

The IBM-704 program RE-147 is used to calculate the time and space-dependent temperature distribution in a solid cylindrical fuel pin, cooled on the surface, with internal heat generation. The fuel pin may be bare or clad, and its boundary may be cooled by either flowing or stagnant coolant. The heat generation source may also be time and space dependent. Specifically, the program considers the fuel pin to be composed of two regions and then solves, by the usual finite difference methods, the heat conduction partial differential equation in the two regions. Simultaneously, the axial and time variation of the coolant temperature is calculated by a finite difference approximate solution of the energy equation for the coolant. An approximate method is included to allow for the effects of solid-state phase changes. In conjunction with the phase-changing procedure, the material properties are permitted to vary from one phase to the next. (auth)

8942 (ANL-6256) THE EFFECT OF THE LIQUID VISCOSITY IN TWO-PHASE, TWO-COMPONENT FLOW. Melvin Jerome Fohrman (Argonne National Lab., Ill.). Nov. 1960. 108p. Contract W-31-109-eng-38.

An evaluation was made of the effect of the liquid-phase viscosity on slip ratio using a forced-circulation two-phase two-component system operating at atmospheric pressure for air and glycerol-water mixtures. The effect of liquid-phase viscosity on pressure drop was observed, and the flow regimes were identified and studied. The approximate ranges of the variables investigated were: liquid viscosity, 0.75 to 500 cp; quality, 0.005 to 0.0184; liquid flow rate, 0.2 to 0.8 lb/sec; air flow rate, 0.001 to 0.015 lb/sec; and void-volume fraction, 0.34 to 0.78. The void-volume fraction and the approximate distribution of the two-phase mixture at a particular cross-sectional element of the test section were determined by γ-attenuation techniques. The slip-ratio and pressure-drop results were not found to indicate any considerable variations caused by changes in flow pattern or liquid flow rates for the range of flow conditions and liquid viscosities encountered. (B.O.G.)

8943 (ANL-6291) HEAT TRANSFER TO A MIST FLOW. Technical Report No. 5. Jerald D. Parker and Richard J. Grosh (Purdue Research Foundation, Lafayette, Ind.). Jan. 1961. 245p. For Argonne National Lab. Contract W-31-109-eng-38, Subcontract 31-109-38-704.

An experimental and analytical study was made of the heat-transfer characteristics of a mist flow of steam and water droplets flowing vertically upward in a round tube. A simplified analytical model, based on momentum, mass, and energy considerations, was developed which shows qualitatively that severe temperature fluctuations are characteristic of such flows under constant-wall heat-flux conditions. The experimental data showed that the analytical model gave a fairly accurate qualitative description of the tube-wall temperature variation with length. The analysis of the data seemed to indicate that the assumptions of equilibrium between phases and constant values for the mass-transfer coefficient for droplets were incorrect. (auth)

8944 (ARF-1167-6) FEASIBILITY STUDY OF A NEW MASS FLOW SYSTEM. Quarterly Report No. 2 Covering the Period from September 1 to November 30, 1960. G. M. Burgwald (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Dec. 19, 1960. 34p. Contract AT(11-1)-578.

Includes Quarterly Report No. 6, Period from September 1–November 30, 1960. William K. Genthe (Badger Meter Mfg. Co., Milwaukee).

Activities in a development program for a mass flow system capable of measuring homogeneous flow, slurries, highly corrosive fluids, and multiphase fluids are reported. The first experimental mass flow meter is nearly complete, and the required intensity of the radioactive source for mass measurements is being determined. Design of the vibrating reeds for the sources are completed. Absorption measurements at energies <100 kev indicate that composition effects are present, however, the effect is not considered serious since the system can be calibrated for each particular material. (J.R.D.)

8945 (CF-59-8-31) RADIATORS FOR SPACE POWER PLANTS. A. P. Fraas (Oak Ridge National Lab., Tenn.). Aug. 7, 1959. 8p.

An improved heat sink for space vehicles was proposed in Oak Ridge National Laboratory Report CF-59-1-21. Subsequent work on the problem indicated a substantial probability of a puncture of such a radiator by meteors. To meet this problem, a modified geometry was evolved for which the probability of a meteor puncture should be reduced by a factor of at least 100, relative to the radiator of the original proposal, at the expense of an increase in radiator weight of possibly 30%. This proposal constitutes what is believed to be a new concept in the design of radiators for space vehicles in that fins are provided on the radiator tubes in such a manner that, when used in conjunction with an involute heat reflector, they protect the vulnerable portion of the tube wall from direct impingement by meteors, and in this way the fins greatly reduce the probability of a puncture. (auth)

8946 (CF-59-8-33) TEMPERATURE AND RATE OF HEAT REMOVAL OF UO_2 TEST ELEMENTS. J. R. Nix (Oak Ridge National Lab., Tenn.). Aug. 5, 1959. 10p.

The method of calculation of various quantities relating the temperature and the rate of heat removal of UO_2 test elements is presented. Graphs of the appropriate quantities as a function of the rate of heat removal are included. (auth)

8947 (CF-59-11-57) STEADY STATE TEMPERATURE DISTRIBUTION IN A THIN CYLINDRICAL SHELL WITH PIECEWISE VARIATION OF EXTERNAL HEAT TRANSFER COEFFICIENT, EXTERNAL COOLANT TEMPERATURE, AND INTERNAL HEAT INPUT. Fred H. Abernathy (Oak Ridge National Lab., Tenn.). Nov. 13, 1959. 20p.

The steady-state temperature distribution was determined for a thin cylindrical shell subject to heat input on the inner surface and heat transfer on the outer surface. The shell was divided mathematically into a number of segments along the circumference. In each segment the heat input on the inner surface, the convective heat-transfer co-

efficient on the outer surface, and the external coolant temperature was taken to be constant; however, all of these parameters were allowed to vary from segment to segment. The temperature distribution was assumed to be a function of the circumferential space coordinate alone. (auth)

8948 (CF-60-10-6) FUNDAMENTAL STUDIES IN HEAT TRANSFER AND FLUID MECHANICS. Status Report July 1, 1959–Feb. 29, 1960. H. W. Hoffman, W. R. Gambill, J. J. Keyes, Jr., and G. J. Kidd, Jr. (Oak Ridge National Lab., Tenn.). [nd]. 28p.

Experimental determinations of heat-transfer coefficients, burn-out heat fluxes, and friction factors were made for swirl flow of low- and moderate-pressure water through electrically heated aluminum, nickel, and copper tubes containing full-length Inconel twisted tapes. For nonboiling conditions, swirl-flow heat-transfer coefficients were successfully correlated with both the Froude modulus (the ratio of inertial to centrifugal forces) and a grouping of the Grashof and Reynolds moduli (ratio of buoyant to inertial forces). Under local-boiling conditions the effect of tape-twist ratio was clearly noted with the tighter tapes supporting a higher surface heat flux for a given superheat. At low pressures, swirl-flow burn-out heat fluxes were about twofold larger than for straight flow through the same tube at equal pumping power. Recommended correlations are given for the separate flow regimes and for burn-out. Friction factors for swirl flow were observed to be as much as threefold larger than those found for axial flow in smooth pipes. A systematic study has been undertaken of the effects of injection velocity, mass flow rate, pressure, and tube geometry on the vortex strength and the velocity profile in a gaseous jet-driven vortex tube under conditions approximating a two-dimensional flow field. It was found for the same jet input power and pressure that subsonic injection was more effective than supersonic injection in generating vorticity and that reducing the tube diameter resulted in a pronounced increase in the peripheral Mach number. No effect of L/d was observed. The degree of approach to potential vortex flow appears to be influenced primarily by the ratio of the radial to tangential Reynolds modulus (the higher the ratio, the closer to potential vortex flow). An estimate of the degree of turbulence at the tube wall was obtained by using the velocity-profile data to estimate a virtual viscosity (μ^*/μ) for the fluid. The lowest value determined for μ^*/μ was 30 for a wall pressure of 2.5 psia; it is concluded that flow near the wall in jet-driven vortex tubes will in all probability be turbulent for pressures in excess of a few tenths psia. (auth)

8949 (HW-65706) STEAM-WATER PRESSURE DROP AND CRITICAL DISCHARGE FLOW–A DIGITAL COMPUTER PROGRAM. W. A. Massena (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 17, 1960. 23p. Contract AT(45-1)-1350.

The program calculates the characteristic curve of the exit pressure vs. flow rate for steady flow in a piping system with specified inlet pressure, inlet enthalpy, geometry, and frictional resistance. It computes the critical flow rate and critical pressure. The program will accept both saturated and subcooled inlet conditions. The program was coded for the IBM-709 computer. (W.L.H.)

8950 (IS-197) PROGRESS REPORT ON FRICTION LOSS OF SLURRIES IN STRAIGHT TUBES. Glenn Murphy, Michael A. McCoy, and Harold E. Wolfe (Ames Lab., Ames, Iowa). Sept. 1960. 98p. Contract W-7405-eng-82.

Work on the evaluation of the head loss of slurries flowing in horizontal and vertical tubes is summarized. The slurries used in the investigation were spherical glass beads and ion-exchange resin particles suspended in water. The tube size used was approximately 0.3-in. in inside diameter. Concentrations from zero to approximately 50 wt.% were used. The results are presented in graphical form as head loss in feet of mixture vs. Froude number and a "Z-factor" vs. Froude number. The Z-factor is evaluated as the ratio of the pressure drop of the pure fluid to the pressure drop of the mixture flowing at the same mean velocity. The relation between the Z-factor for turbulent flow and concentration is presented in graphical form for the three directions of flow. (auth)

8951 (KAPL-M-S3G-RES-74) EVALUATION OF M-130 HEAT TRANSFER TEST. James L. Nash (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 5, 1960. 37p. Contract W-31-109-Eng-52.

The M-130 thermal test was designed to prove the ability of the cask to operate at design limits. Although the test procedure did not lend itself to a direct extrapolation of the data, the operating margin is sufficient to insure that the cask will meet all thermal design requirements. The thermal design analysis was used to predict cask temperatures during the test. The maximum primary coolant temperature measured during the shipping test was within 3.6°F of the calculated temperature. Most of this temperature difference is involved in calculating primary coolant flow rates. Other parameters such as the water temperatures of the secondary system were within 0.3°F of the measured values. In the loading test, the maximum predicted primary coolant temperature was within 14.3°F of the measured temperature. It is interesting to note that 11.7°F of this discrepancy is due to the calculation of primary flow rate. It is believed that the high primary flow rate experienced during the loading test is a result of nucleate boiling on the heater surface and will not appear in actual operation due to the large heat-transfer area and low flux of a fuel module. Making use of the test data, the maximum primary temperatures were calculated for both shipping and standby operation at the design ambient temperature of 110°F. The maximum primary temperature during shipping is approximately 192°F. This compares to a maximum allowable primary temperature of 267°F. The maximum primary temperature during standby operation was calculated to be 171°F. This compares to an allowable primary temperature during loading of 212°F. Generally speaking, the thermal test was entirely adequate as a proof test and enables KAPL to check at least by inference, some of the major parts of the thermal analysis. However, many important phenomena could not be measured due to the limited instrumentation. It would be desirable to run an additional test that is designed to make direct measurements of component performance. This test would permit the operational limits to be accurately determined and should suggest design changes to improve operation. (auth)

8952 (LA-2412) DYNAMICS OF COMPRESSIBLE FLUIDS. Francis H. Harlow (Los Alamos Scientific Lab., N. Mex.). Apr. 1960. 200p. Contract W-7405-ENG-36.

A compilation of numerous topics in the theory of compressible-fluid dynamics is presented. The presentation is designed as a guide for students, as well as a source of reference for the research worker. The choice of material was influenced by the needs and projects at the Los Alamos Scientific Laboratory, where much of the theoretical work in fluid dynamics is carried out by numerical techniques on high-speed electronic computers. However, the numerical methods are not discussed. (auth)

8953 (LAMS-2379) METHODS OF DIFFERENCING IN EULERIAN HYDRODYNAMICS. H. Jerry Longley (Los Alamos Scientific Lab., N. Mex.). Feb. 1959. 83p. Contract W-7405-eng-36.

Methods of differencing the Eulerian form of the hydrodynamic equations were investigated to find a method for machine calculations which could be used in hydrodynamic problems involving large distortions of matter in two-space dimensions. Boundaries between materials were carried and moved through the fixed Eulerian mesh. Given a mesh at some time and with proper boundary conditions the problem was to carry the values of the quantities stored in each mesh point forward in time explicitly to a small time later. A discussion of the problem in one-space dimension and then for the case of two dimensions was included. (auth)

8954 (NAA-SR-Memo-5431) HEAT TRANSFER FOR 43 AND 55 Th–U FUEL ELEMENT CORES IN SRE. E. H. Spoehel (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 23, 1960. 10p.

Calculations were made to determine power removal and temperatures for the SRE with 5-rod Th–U^{235} alloy fuel elements. Allowable power from 43 fuel elements with 1400°F nominal peak fuel temperature is 37 Mw(t). Variation in peak fuel temperature with hot channel factors is ±130°F. Available power for temperatures 1300 to 1500°F varies from 30 to 44 Mw(t). At 45 Mw(t) a core of 55 elements would have corresponding temperatures of 1385°F nominal and 1260 to 1510°F with hot-channel factors. (T.R.H.)

8955 (NP-9264) THE SEPARATION OF LIQUID FROM GAS IN A PIPELINE. EXPERIMENTS WITH AIR AND WATER IN A HORIZONTAL 4" PERSPEX PIPE. (New Zealand. Dominion Lab., Wellington). Aug. 24, 1955. 5p. (DL. 118/6-GMS)

Investigations of the flow and separation of two-phase mixtures in horizontal pipes are described. The most successful separator tested consisted of a tee in which the gas passed along the top and the liquid was permitted to fall down into a side tube. Performance curves are included. (J.R.D.)

8956 (NP-9770) EXPERIMENTS ON FLOW OF GASES THROUGH LEAKS. A. Nerken (Vacuum-Electronic Engineering Co., New Hyde Park, N. Y.). [1957?]. 7p.

Experiments were conducted to determine the flow rates of gases (other than air) through leaks under various conditions which included: (1) leak sizes, (2) pressure difference across the leak, (3) characteristics of the gas, and (4) gaseous composition. Flow rates are shown graphically for helium and nitrogen for leaks 6, 3, $1\frac{1}{2}$, and $\frac{1}{8}$ in. in length. The effects of air, argon, carbon dioxide, Freon-12, helium, hydrogen, and oxygen on helium and nitrogen flow rates are tabulated. (B.O.G.)

8957 (NP-9780) HEAT TRANSFER IN OSCILLATING FLOW. Second Progress Report for the Period October 1, 1959–September 30, 1960. Aeronautical Engineering Report No. 483-b. David T. Harrje (Princeton Univ., N. J.). Oct. 20, 1960. 20p. Contract USN-NONR-1858(29).

The investigation of heat transfer in oscillating flow was continued. A series of tests to further investigate the dependence of heat transfer on various parameters was made for three locations of the heat-transfer section along the duct at several harmonic frequencies with pressure amplitudes varying from 0.4 steady-state pressure to zero. (W.L.H.)

8958 (NP-9802) STABILITY OF SIX- AND NINE-POINT DIFFERENCE ANALOGUES OF THE DIFFUSION EQUATION. Interim Report No. 1. W. Robert Mann and John Gwynn, Jr. (North Carolina. Univ., Chapel Hill). June 1960. 21p. Contract DA-36-034-ORD-2896RD.

The stability and truncation error of six- and nine-point finite difference analogs of the heat-diffusion equation are discussed. Analogs were obtained by approximating derivatives with finite differences; the use of more general differences than are ordinarily employed has led to some analogs previously undiscovered. A representation is given of general six- and nine-point analogs in a form convenient for stability analysis, from which several results relating stability, truncation error, and explicit or implicit nature of the analog were obtained. (auth)

8959 (TID-6611) EFFECTS OF DISSOLVED GAS EVOLUTION AT THE SURFACES OF HEATED VERTICAL CYLINDERS (thesis). Jerry R. Peterson (Columbia Univ., New York. Engineering Research Labs.). Sept. 25, 1960. 51p. Contract AT(30-3)-187.

The results are presented from a study of the effects of dissolved gas evolution at the surfaces of heated vertical cylinders. Water velocities to 1 ft/sec were investigated for flow, both normal and parallel to vertical cylinders. The study was carried out at atmospheric pressure, and the cylinder surface temperature maximum was 212°F. Several concentrations of air and nitrogen were investigated. The data obtained fell into two regions: one at low heater-surface temperatures, where the presence of dissolved gases had no apparent effect, and the other at high heater surface temperatures, where the heat-flux density increased considerably because of the presence of the gases. The data in the latter region were correlated in terms of the saturation temperature of the dissolved gas by the equation: $q/A = 0.0038\ \Delta t_{sat}^{3.45}$. The data were also correlated in terms of the partial pressure of the dissolved gas by an equation involving an empirical driving force, $\Delta P'$: $q/A = 0.085\ (\Delta P')^{2.9}$. (auth)

8960 (TID-6765) BASIC STUDIES IN HEAT TRANSFER AND FLUID FLOW. Quarterly Progress Report IX-QPR-3-60 for period July 1, 1960 to September 30, 1960. T. Diskind, D. Lee, R. Lummis, R. P. Stein, and J. H. Vohr (Columbia Univ., New York. Engineering Research Labs.). 15p. Contract AT(30-3)-187.

The resistance and temperature coefficients of "E.C." films (copper film covered with MgF_2 film) were measured. The third test section heater (heated portion of each test section consisted of a stainless-steel tube 0.295 in. OD × 0.025 in. wall × 10.5 in. long) was used to determine the critical heat flux density of the heater using the pulse heating technique at conditions of 0.4 ft/sec water velocity, 170°F inlet temperature, and 17 psia. Burn-out occurred at a heat flux of 750,000 Btu/hr/sq ft. Sustained, but not stable, film boiling was achieved in a fourth test section heater using the pulse heating technique. A smooth vapor film was obtained momentarily at relatively low steady-state heat fluxes over a significant portion of the tube surface. In studies on boiling water flow patterns, difficulties are encountered in finding a satisfactory method of thermally insulating the back side of the heating strip to prevent boiling from occurring beneath the strip. (For preceding period see TID-6035.) (C.J.G.)

8961 (TID-11549) BASIC STUDIES IN HEAT TRANSFER AND FLUID FLOW. Quarterly Progress Report for Period October 1, 1960–December 31, 1960. (Columbia Univ., New York. Engineering Research Labs.). 36p. Contract AT(30-3)-187. (IX-QPR-4-60).

Transient vaporization experiments were conducted to determine the usefulness of conductive-film heaters in boiling experiments and the qualitative functional relation between surface temperature and time during boiling. Discussions are given of results on the influence of liquid conductivity on the performance of conductive films, the visual

characteristics of heat transfer from conductive films, and temperature measurements on conductive films. Graphical representations are given of the results for the electrical heat-generation rate, and relative change, in electrical resistance as functions of pulse time. A series of concentric heat-transfer and pressure-drop experiments was completed using a nickel heater tube. The pressure-drop results are shown as friction factors as a function of Reynolds number with a standard curve for comparison. The concentric heat-transfer tests covered heat-generation rates to 500,000 Btu/hr-ft^2 and water velocities of 2 to 25 fps. (B.O.G.)

8962 HEAT TRANSFER TO SODIUM-POTASSIUM ALLOY IN POOL BOILING. Niels Madsen (Rhode Island Univ., Kingston) and C. F. Bonilla. Chem. Eng. Progr., Symposium Ser., 56: No. 30, 251-59(1960).

Film coefficients are presented for sodium–potassium alloy (44 wt.% K) boiling on a horizontal surface. The heat transfer at the boiling surface was calculated by subtracting the heat loss to the surroundings from the electrical input to the heater. Temperatures in the boiling liquid and the vapor space above it were also determined. The best temperature differential for computing the heat-transfer coefficients was found to be the difference between the boiling surface temperature and the equilibrium boiling point of the sodium–potassium alloy at the pressure of the vapor space. A correlating equation was derived statistically for heat velocity as a function of pressure and temperature differential. (auth)

8963 FORCED CONVECTION HEAT TRANSFER IN PIPES WITH INTERNAL HEAT GENERATION WITHIN THE FLUID FLOW. B. S. Petukhov, L. G. Genin, and V. L. Mal'ter. Inzhener.-Fiz. Zhur., Akad. Nauk Belorus, S.S.R., 3: 3-9(Sept. 1960). (In Russian)

It is shown that calculations of heat transfer for a stabilized flow of fluid with constant physical properties and internal heat generation can be made by means of the usual formulas for heat transfer during flow without internal heat generation, if the coefficient of heat transfer is calculated by the difference between the temperature of the wall and the adiabatic temperature of the wall. On the basis of modern data on the velocity and eddy diffusivity of momentum distribution obtained by Reichardt, numerical calculations of the adiabatic wall temperature were made for Reynolds modulus from 10^4 to 10^6 and Prandtl modulus from 0 to 100. Interpolation formulas for calculating the adiabatic wall temperature, approximating results of theoretical calculations with an accuracy of ±10%, are proposed. The results obtained for the adiabatic wall temperature were compared with the results of Poppendiek's calculations and were in good agreement with experimental data obtained by Muller. (auth)

8964 THE EFFECT OF AGITATING MATERIAL IN A FLUIDIZED BED ON HEAT EXCHANGE BETWEEN GAS AND PARTICLES. A. P. Baskakov. Inzhener.-Fiz. Zhur., Akad. Nauk Belorus. S.S.R., 3: 10-16(Sept. 1960). (In Russian)

Data obtained show that in calculating heat transfer between the gas and suspended phase, agitation of the solid phase along the height of industrial single-hearth apparatus with fluidized bed should be considered ideal. Counterflow can be effected only in small-diameter installations (60 to 100 mm). When the material is ideally mixed, agitation of gas has little effect. In calculation it should also be considered ideal. (auth)

8965 INTERPRETATION OF HEAT EXCHANGES FOR HIGH HEATING SURFACE CHARGE. H. Uschwa (Deutsche Babcock & Wilcox Dampfkesselwerke A.G., Oberhausen). Kerntechnik, 2: 400-4(Dec. 1960). (In German)

By utilizing the addition theorem of comparable stresses in the transformation energy hypothesis and by the elementary law of heat transfer, a formula for practical use was derived for the case of a tube heated internally and under internal excess pressure. The formula permits the maximum possible heating surface charge to be determined as a function of the material value of the tube, the tube dimensions selected, and the safety factor proposed for the calculation. (tr-auth)

8966 EXPANSION LOSSES IN TWO-PHASE FLOW. P. A. Lottes (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 9: 26-31(Jan. 1961).

Four methods are discussed for predicting the change of static pressure across an abrupt expansion for the flow of liquid vapor mixtures. Design equations are given and recommendations are made for boiling reactor calculations. (auth)

8967 THE TUNNEL THEORY OF FLUIDS: THE 12:6 FLUID. J. A. Barker (Commonwealth Scientific and Industrial Research Organization, Melbourne). Proc. Roy. Soc. (London) A, 259: 442-57(Jan. 24, 1961).

A theory of fluids is described based on a tunnel model, in which lines of molecules are pictured as moving almost one-dimensionally in tunnels or fine capillaries, the walls of the tunnels being formed by neighboring lines of molecules. This model is similar to the cell model in that the whole fluid is broken down into subsystems sufficiently simple to permit explicit calculation of their properties; in the cell model, the subsystems are single molecules moving in cages, in the tunnel theory they are whole lines of molecules moving in tunnels. The advantages of the tunnel model are that density fluctuations are permitted in a natural way, so that the difficulty of the communal entropy is no longer insuperable and so that the basic structure is a disordered one, since the molecules in different tunnels are randomly placed with respect to each other. This model has already been shown to give a good description of the hard-sphere fluid. It is applied to the 12:6 fluid and is shown to give values for liquid densities, compressibilities and vapor pressures which are satisfactorily close to the experimental values for simple liquids. The calculated critical constants are less satisfactory, probably because the approximation of treating the motion along the tunnels as one-dimensional is less accurate at low densities. (auth)

8968 MODIFICATION OF THE GAS CURRENT BY AN ELECTRIC ARC BURNING IN THE NOZZLE. Karl Zückler (Siemens-Schuckertwerke AG, Berlin). Z. angew. Phys., 12: 567-75(Dec. 1960). (In German)

The dependence of the stationary current resistance on the output of an arc burning in a nozzle was investigated experimentally. The relationship found was proved theoretically with the help of simplifying assumptions and applied to the relationship existing in the solution of alternating arcs. The hindrance of the current produced by the inertia of the gas mass was estimated at the time of the zero current passage. (tr-auth)

8969 RADIANT HEAT TRANSFER FROM TAPERED FIN WITH CONSTANT TEMPERATURE GRADIENT, UNIFORMLY HEATED AT ROOT SECTION. Donald B. Mackay (North American Aviation, Inc., Downey, Calif.). Preprint No. 24 for the Fourth National Heat Transfer Conference of the American Institute of Chemical Engineers and American Society of Mechanical Engineers, Buffalo, N. Y.

Aug. 14-17, 1960. 61p. New York, American Institute of Chemical Engineers.

A method is presented for determining the amount of heat that can be rejected from tapered fin surfaces by radiation heat interchange with the environment. A fin of minimum material with linear temperature gradient is emphasized. The removal of material from a fin to provide this gradient leaves the fin with a two-dimensional concave surface. To this type of fin, mathematical analyses are directly applicable. For simplicity, the desired quantities of such factors as heat transfer and weight are expressed in terms of the fin root thickness, the length, and the ratio of the absolute temperatures of the hot and cold ends of the fin. The third parameter, in most instances, enters into the equations as complicated functions which, for convenience, are grouped together. Because the evaluation of these groups was quite tedious, values were computed on an IBM machine and the results plotted for use in graphical form. Most problems encountered can be solved with the use of these graphs. Methods are presented for computing heat transfer, fin weight, and fin contour as well as for design optimization. Sample problems illustrate the method and the magnitude of results to be expected. Approximate evaluation of triangular fins is also presented. (auth)

8670 DECONTAMINATION DEVICE FOR HEAT EXCHANGERS IN NUCLEAR POWER PLANTS. (to Société Parisienne de Constructions). French Patent 1,204,415. Jan. 26, 1960.

In the primary circuits of heat exchangers in nuclear power plants the circulating fluid is often radioactive; so this primary circuit has to be decontaminated from time to time. For this purpose the primary circuit is rinsed first with a suitable chemical reagent and then with water. This last rinsing is performed by condensing steam on the exchange surfaces of this circuit. The condensation may be made possible by the presence of cold water in the secondary circuit. In this way all exchange surfaces are rinsed. This rinsing is performed by filling the secondary system beforehand with cold water and then progressively draining it from the top downward. (NPO)

8971 IMPROVEMENTS IN HEAT EXCHANGERS. (to Dürwerke A. G.). French Patent 1,210,852. Mar. 11, 1960.

A boiler is described for use preferably in nuclear power stations, wherein the fluid heated in the reactor circulates in a closed circuit and transfers the heat successively to a plurality of tube systems in which the working fluid is evaporated. The boiler controls are responsive to variations in the exit temperature of the heating fluid and change the circulation rate in the individual tube systems; in this way they change the heat-transfer characteristics in these systems, keeping the boiler exit temperature, which is equal to the reactor entrance temperature, essentially constant. This may be performed by diversion of the working fluid from the principal circuit, comprising most of the systems in series, to a last system arranged at the low temperature end of the boiler. (NPO)

8972 TWO STAGE BOILER INSTALLATION. (to General Electric Co., Ltd.). French Patent 1,212,851. Mar. 28, 1960.

In a two-stage boiler (preferably for nuclear power plants) the blower circulating the heating gas is driven by a turbine fed by the steam of the high-temperature stage superheated before passage to the turbine. The steam leaving this turbine is mixed with the steam produced in the low-pressure boiler and feeds, after being superheated, the low-pressure stage of the turbogenerator of the plant. The blower may be installed inside the boiler-containing shell. (NPO)

8973 HEAT EXCHANGER WITH FINNED OR CORRUGATED TUBES IN CONNECTION WITH COILS OF TUBING. (to M. A. Huet). French Patent 1,213,806. Apr. 4, 1960.

A heat exchanger arrangement is described. It is placed inside a cylindrical vertically placed containing tube in which the heating fluid circulates, transferring the heat to a plurality of heat exchange tubes inside which a liquid may be evaporated. In the evaporating part of the heat exchanger, tubes wound to coils may be arranged; rectilinear tubes are provided near the containing wall and/or near the axis of the container inside the coils of tubes. The rectilinear tubes are suitably finned; deflecting sheets may be arranged between these tubes. The tube system may be suspended by the inner rectilinear tubes. (NPO)

8974 HEAT EXCHANGER WITH INTERMEDIATE FLUID. (to Société Francaise des Constructions Babcock & Wilcox). French Patent 1,214,943. Apr. 12, 1960.

A heat exchanger (preferably for nuclear reactors) comprises a first space in which the heating fluid circulates, a second space traversed by the cold fluid, and a third space formed by the walls bounding the said first and second spaces, respectively. This third space is filled by a thermally conductive liquid that is immiscible with the other fluids. Preferably, the first space is constituted by the inside of the inner tubes of a plurality of parallelly arranged double-walled tubes connected at their ends by headers. The second space is that between the containing shell and the outer of the double-walled tubes. The thermally conducting liquid is filled into the annular interspaces of the double-walled tubes. This last liquid is held at a lower pressure than the other fluids. (NPO)

8975 IMPROVEMENTS IN THE HEAT EXCHANGE OF FINNED FUEL ELEMENTS IN A NUCLEAR REACTOR. (to M. G. H. Girodin). French Patent 1,215,822. Apr. 20, 1960.

In order to improve the heat transfer between the longitudinal or helicoidal finned fuel elements and the coolant, graphite rings are arranged around the fins at intervals along the coolant channel. These rings may have a nozzle form or some other convergent shape of the profile. They create turbulences around their profiles. In another embodiment the pitch of the helicoidal fins is sufficiently low that the transverse effect of the fins is predominant. In a last embodiment the fins have notches forming in their turn helicoidal channels. (NPO)

8976 IMPROVEMENTS RELATING TO THE COOLING OF LONGITUDINAL FINS BY FLUID CIRCULATION. (to Commissariat à l'Énergie Atomique). French Patent 1,219,325. May 17, 1960.

Cylindrical fuel elements having longitudinal cooling fins and being arranged in reactor channels in which the coolant circulates essentially in axial direction are surrounded by annular rings in order to create at the outer surface of these rings a lowering of pressure which induces a partial renovation of the boundary layer downstream of these rings. The places where a lowering of pressure is created are at well-defined distances apart, and at these places the fins have transverse slits. These rings may have sharp edges on the down-stream side and be smoothly profiled on the up-stream side. They may also have the profile of a classical wing. Instead of rings, a helically wound strip may be arranged coaxial with the fuel elements. The down-stream edges of the fins may be profiled also, in the vicinity of the said slits. (NPO)

8977 HIGH TEMPERATURE HEAT EXCHANGER. (to M. A. Huet). French Patent 1,221,652. June 3, 1960.

In order to avoid too high temperatures of the containing shell of a high-temperature heat exchanger working with high-pressure heating fluids, means are provided to cool or insulate the parts of the shell near the high-temperature entrance of this heating fluid. For this purpose, the pressure wall may be covered with cooling coils or protected inside by a fluid layer at a lower temperature. In the coils or in this layer, water, wet steam, or heating fluid that has reached a lower temperature may circulate. Suitably, the entrance of the heating fluid is shaped to a Venturi tube, exhausting through openings at its smallest diameter the low-temperature heating fluid from the said thermal protection layer. (NPO)

8978 EVAPORATOR AND BOILER PREFERABLY FOR NUCLEAR REACTORS. (to M. G. Trepaud). French Patent 1,226,456. July 13, 1960.

An evaporator is described comprising a plurality of double-walled vertical tubes parallelly arranged whereby the heating fluid circulates inside the annular spaces between the tubes, the evaporating fluid being inside the inner tubes and outside the outer tubes. The velocity of circulation is controlled independently in two independent circuits formed by the inside of the said inner tubes on the one hand and by the outside of the outer tubes on the other hand. This regulation is performed preferably by a controlled reduction of the circulation in the space outside the tubes. The heating fluid may be pressurized by heavy water or carbon dioxide. A vertical column in which the evaporating fluid is held at a constant level feeds at its base the two evaporator circuits. (NPO)

Instrumentation

8979 (AECL-802) PROCEEDINGS OF THE SIXTH TRIPARTITE INSTRUMENTATION CONFERENCE, HELD AT CHALK RIVER, ONTARIO, APRIL 20-24, 1959. PART 2: RADIATION DOSIMETRY. J. E. Woolston and S. J. Townsend, eds. (Atomic Energy of Canada Ltd., Chalk River, Ont.). June 1960. 155p.

Papers on radiation dosimetry and health instruments presented at the Sixth Tripartite Instrumentation Conference are given. One abstract of a paper is also included. Separate abstracts have been prepared for one of the papers. Five were previously abstracted for Nuclear Science Abstracts. (M.C.G.)

8980 (AECL-802(p.1-4)) HEALTH-PHYSICS INSTRUMENTATION AT BROOKHAVEN NATIONAL LABORATORY. Frederick P. Cowan (Brookhaven National Lab., Upton, N. Y.).

An electronic scanner for nuclear-track films used in personnel monitoring was tested and evaluated. A background count of four per scanning cycle of 180 fields was obtained. In studies on cosmotron dosimetry, the average relative biological effectiveness for the scattered radiation to which people are exposed was determined. A value of 8 was obtained by the cloud chamber method. An electronic reader for pocket dosimeters was developed and proved to be very reliable in routine use. Work was also carried out on the development of thermoluminescent phosphors as radiation detectors. (M.C.G.)

8981 (AECL-802(p.5-24)) SOME TRENDS FOR RECENT HEALTH-PHYSICS INSTRUMENTATION DEVELOPMENTS AT HANFORD. R. A. Harvey (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). (HW-59711).

The work of the Radiation Protection Instrument Research and Development Operation of the Hanford Laboratories is reviewed. In general, two groups of instrumentation are considered: survey and monitoring instruments and special-purpose instruments. Descriptions are given of transistorized scintillation hand and shoe counters, an analyzing stack-effluent radioisotope monitor, α air monitors, and all-automatic data-gathering and radio telemetering system for meteorological and radiological purposes, a solar-radiation integrator, an instrument for rapidly determining the number of zinc-sulfide particles on a filter, and instruments for delineating the radioactivity in various types of experimental animals. Photographs are included. (auth)

8982 (AECL-802(p.25-32)) REVIEW OF RADIATION DOSIMETRY AT CHALK RIVER. G. Cowper (Atomic Energy of Canada Ltd., Chalk River, Ont.).

An instrument for monitoring airborne H^3 was developed and tested. Operation was satisfactory in external γ fields of up to several mr/hr. An accounting system using IBM cards was devised in order to sort personnel records with a view to obtaining the optimum deployment of personnel within the radiation dosage limits set by the ICRP. This data system permits the extraction of the following information: 14-week total, calendar-year total, previous consecutive 14-week totals, approximate running-year total, previous calendar-year totals, and lifetime total. (M.C.G.)

8983 (AECL-802(p.33-6)) TRANSISTORIZED HEALTH INSTRUMENTS. R. J. Cox (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England).

A three-decade logarithmic rate meter, primarily intended for neutron area monitoring, is described. A count rate of 0.5 to 500 counts/sec, with an accuracy of ±10% of the count rate, was obtained. A d-c trip amplifier intended for use with a Geiger counter for monitoring the release of activity into gas or liquid coolants is also described. Sensitivity is adjustable from 3×10^{-11} to 1×10^{-8} amp for full-scale deflection. The effect of a 30°C temperature change gave a drift of less than 1% full-scale deflection even on the most sensitive range. (M.C.G.)

8984 (AECL-802(p.37-40)) GAMMA DOSIMETRY BY CHEMICAL TECHNIQUES. S. C. Sigoloff (Edgerton, Germeshausen and Grier, Inc., Las Vegas, Nev.).

The chemical system as utilized for γ dosimetry consists of tetrachloroethylene (TCE) which contains a small amount of free-radical chain-reaction retarder, overlayered with an aqueous phase containing a pH indicator. Thermal neutron sensitivity of the TCE was reduced to a negligible amount by appropriate lithium shielding. The use of stabilizers made it possible to produce TCE dosimeters that can register doses in the range 5 to 2×10^6 rads and show excellent reproducibility. A ratio-recording two-band absorption-filter colorimeter was used to measure the pH changes in the chlorphenol red indicator. (M.C.G.)

8985 (AECL-802(p.52-4)) AREA RADIATION MONITOR. L. Cathey (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.).

An area radiation monitor was built which utilizes a scintillation counter with a 3 by 3 in. cylindrical crystal of NaI(Tl). All interactions that release more than 10 kw in the crystal are counted. Using the monitor it was possible to detect a change in radiation level corresponding to 5% of the cosmic-ray level. Results showed that to be most effective a monitor must be mounted under any thick roof of concrete and clear of any roof-support structures. (M.C.G.)

8986 (AECL-802(p.55-7)) SEVEN-DECADE INTEGRATOR. P. L. Owings (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.).

An integrator with unusual dynamic range was developed for use with ion chambers. By means of analog-to-pulse repetition-rate conversion of the signal represented by the ion-chamber current and automatic decimal-point shifting, a dynamic range of seven decades was achieved. The integrator was designed to receive as its input signal the voltage output from a Beckman logarithmic micromicroammeter. The micromicroammeter output is proportional to the logarithm of the current from an ion chamber. The pulse rate is proportional to the ion-chamber current. (M.C.G.)

8987 (AECL-802(p.58-60)) BETA DOSIMETRY WITH THIN SCINTILLATORS. W. G. Cross and J. D. Marr (Atomic Energy of Canada Ltd., Chalk River, Ont.). (CRR-797-2.7).

Beta dosimetry characteristics of thin scintillators were determined and a prototype was constructed. The response of layers of anthracene of different thicknesses was measured by β emitters with end points from 0.23 to 3.5 Mev. Thin layers were made by several different methods but evaporated layers gave the most reproducible results. For a practical β survey instrument, the scintillator thickness chosen (7.5 Mg/cm^2) was a compromise between accurate response to low- and high-energy β rays. (M.C.G.)

8988 (AECL-802(p.61-3)) LOW-LEVEL BETA COUNTING WITH THIN SCINTILLATORS. W. G. Cross (Atomic Energy of Canada Ltd., Chalk River, Ont.). (CRR-797-2.17).

Thin organic scintillators appeared to provide a lower background than gas-filled counters for measurement of β emission from samples of low activity. A variety of counters employing thin scintillators was built and the sources of their residual background investigated. Background sources included the photomultiplier, light pipe, cosmic radiation, and radioactivity in the anthracene, photomultiplier, and shielding. (M.C.G.)

8989 (AECL-802(p.70-3)) WARNING DOSIMETER. A. R. Jones (Atomic Energy of Canada Ltd., Chalk River, Ont.). (CRR-797-2.2).

A warning dosimeter was developed to meet the following requirements: the dosimeter must warn audibly when a dose of 200 mr is exceeded, it must give continuous audible indication of normal operation, and it must not require any auxiliary equipment to reset it. When the ion chamber is irradiated, a high-quality condenser is charged up until the voltage across it is sufficient to trigger the regenerative circuit formed by the electrometer tube and the transistor. This operation switches power to an oscillator circuit containing another transistor. The oscillator changes its mode from pulsed operation to a continuous tone indicating the accumulation of a 200-mr dose. (M.C.G.)

8990 (AECL-802(p.74-81)) PERSONAL RADIATION MONITOR. R. H. Dilworth and C. J. Borkowski (Oak Ridge National Lab., Tenn.).

A personal radiation monitor sensitive to γ radiation intensity is described. Visual indication of the intensity is given at all times by a neon lamp with a flashing rate proportional to the dose rate. If the dose rate exceeds a predetermined threshold, an aural alarm sounds in the form of a tone; the frequency increases in proportion to dose rate. The instrument is of the shape and size of a fountain pen. No off-on switch is provided. Preliminary instruments operated for one month before replacement of the 9-volt mercury battery. (M.C.G.)

8991 (AECL-802(p.94-102)) MONITORS FOR ALPHA AIR CONTAMINATION. W. O. Gentry, R. W. Schede, and R. C. Smith (Oak Ridge Gaseous Diffusion Plant, Tenn.).

The major health-physics instrumentation problem at the gaseous diffusion plants concerns the detection of airborne uranium dust. Present instrumentation requires a 4- to 5-hr delay between the collection of a sample and its measurement. The monitor in use at the Oak Ridge Gaseous Diffusion Plant utilizes a roll of moving filter paper and the reading is printed out after the delay. An impaction type of monitor was investigated as a means of eliminating this delay but provided no improvement because the particle size of the dust from a gaseous release is comparable with that associated with natural radioactivity. Work is in progress on a monitor with fixed filter paper in which the sample is continuously collected. The reading reaches an equilibrium when the rate of collection equals the rate of natural decay. A release is indicated by a rapid change in reading and the lower limit of detection is determined by maximum rate of change in background expected. (auth)

8992 (AECL-802(p.103-5)) WALK-OVER SHOE MONITOR. H. S. Sanders, L. H. Cook, Jr., and H. V. Hardison (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.).

A shoe monitor was developed which consists of 28 Geiger-Mueller tubes each staggered in a frame to cover an area approximately 2 by 4 ft. A signal in excess of the relay alarm setting energizes an alarm circuit composed of a bell and light. One inch of lead between the tubes and concrete floor was necessary to reduce the background to the desired level. The frame containing the tubes is covered by a diamond mesh steel grating, designed to support the weight of several persons at one time. (M.C.G.)

8993 (AECL-802(p.106-8)) CRITICALITY-INCIDENT ALARM. H. S. Sanders, L. H. Cook, Jr., A. L. Burke, and H. V. Hardison (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.).

An instrument was designed to detect the large γ-radiation field which results from a criticality accident and then give an immediate alarm. The detector is an air-filled ionization chamber used in a Neher-White circuit. The measuring circuit is an arrangement of a plate-current microammeter, mercury battery, and resistor. The alarm condition is indicated by a flashing red light and alarm bell. In normal operation, a green light indicates that the instrument is functioning properly. A malfunction of the instrument is indicated by an amber light and buzzer. (M.C.G.)

8994 (AECL-802(p.109-13)) AN AUTOMATIC URANIUM FLUORIMETER. J. Leng, N. F. L. Jupe, and S. D. Simpson (Atomic Energy of Canada Ltd., Chalk River, Ont.). (CRR-797-2.14).

Enhancement of the fluorescence of uranium when irradiated with ultraviolet light by fusing with sodium fluoride is described. The method requires transfer of the uranium samples to small platinum fusion disks, evaporation, the addition of sodium fluoride flux, fusion, and finally, measurement in the fluorimeter. The intensity of the fluorescence given off by the sample is measured by the photomultiplier. The resulting signal is an indication of the uranium present. The automatic fluorimeter is described. (M.C.G.)

8995 (AECL-802(p.114-17)) INCIDENT DETECTION BY GAMMA MONITOR 1638A. R. J. Cox (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England).

A unit designed to energize an alarm circuit if a dose of

γ radiation exceeding 100 μr is received by an ion chamber in less than a pre-fixed time interval is described. An ion chamber, electrometer, and relay are used to measure the γ dose. The chamber is automatically recharged after each dose of 100 μr or at the end of the time interval chosen, whichever occurs first. The γ monitor may be connected to a supervisory control unit to give remote indication of an incident. (M.C.G.)

8996 (AECL-802(p.123-4)) DETECTOR FOR PLUTONIUM IN PUNCTURE WOUNDS. G. H. Gruber (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.).

A scintillation counter with a noise level low enough to permit counting the x rays emitted from plutonium isotopes was developed for checking puncture wounds for plutonium contamination. Using this method, it is no longer necessary to cut flesh samples and prepare a planchet for α counting in order to tell if a wound is contaminated with plutonium. The probe assembly contains a NaI(Tl) crystal with an aluminum-foil window. (M.C.G.)

8997 (AECL-802(p.125-9)) BETA-GAMMA HAND AND FOOT MONITOR. W. D. Howell (Atomic Energy of Canada Ltd., Chalk River, Ont.). (CRR-797-2.13).

An instrument intended to detect small quantities of β-γ activity on hands and/or footwear is described. Although intended for use in low-background areas, provision of a background-compensating circuit permits the monitor to be used in areas several times normal background with reasonable statistical accuracy. Aural and visual indications are provided for safe or unsafe levels of contamination, together with an alarm for an incomplete monitoring operation. (M.C.G.)

8998 (AECL-802(p.130-2)) A DOORWAY PERSONNEL MONITOR FOR USE IN VARYING-BACKGROUND AREAS. J. D. Marr (Atomic Energy of Canada Ltd., Chalk River, Ont.). (CRR-797-2.9).

An alarm system was developed which is sensitive only to fast changes in counting rate such as would be produced by a contaminated person approaching a counter at walking speed. It is insensitive to the general background level and any relatively slow variations that may be superimposed upon the background. In the first model, five NaI(Tl) scintillation counters monitored four aisles. The system was improved by the addition of a photoelectric control in the alarm circuit. This made the alarm system operative only when a person approaching the monitor interrupted the beam of light. (M.C.G.)

8999 (AECL-802(p.133-43)) AUTOMATIC READING AND RECORDING OF DOSIMETER-FILM DATA. Mack Wilhelmsen, DeRay Parker, Robert W. Coulter, and Paul R. Boren (Idaho Operations Office. Health and Safety Div., AEC).

An automatic film-reading system is described in which each dosimeter film is identified with the film badge permanently assigned to a particular individual and densities are read, converted to dosage values, and recorded for each of two areas of the film corresponding to β and γ exposures. The film reader consists of densitometer head, film changer, badge-number matrix, β digital voltmeter, γ digital voltmeter, film-density computer, master control panel, and associated power supplies. Pertinent information, collected and processed by the film reader, is fed to a modified Model-026 IBM card punch which produces a permanent punched record. (M.C.G.)

9000 (AERE-M-751) CONSTANT CURRENT DEVICE FOR RESISTANCE MEASUREMENTS ON PLUTONIUM. J. D. Hill and E. A. Steer (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Nov. 1960. 7p.

A mains driven constant current device is described, having a stability of about 1 part in 5000. (auth)

9001 (AFCRC-TN-60-438) PULSE HEIGHT INDICATOR. Technical Note No. 1. U. Galil and D. Ophir (Israel Inst. of Tech., Haifa). Feb. 23, 1960. 8p. Contract AF61 (052)-196.

A method for use in analysis of pulses produced by the various detectors of an array for extensive measurements in air showers is described. An application of digital methods for pulse measurement in which the sources of information are Geiger counter trays containing up to 16 counters each is presented. The information resulting from the cosmic shower is displayed by dekatrons representing the trays and is photographed. (J.R.D.)

9002 (ANL-6199(p.71-81)) FACTORS DETERMINING THE ULTIMATE DETECTION SENSITIVITY OF GAMMA SCINTILLATION SPECTROMETRY. Harold A. May and L. D. Marinelli.

Factors are discussed which influence the choice of the crystal size in γ scintillation spectrometers. Empirical data relative to a practical system are reviewed, and the maximum sensitivity for a typical situation is calculated. (C.H.)

9003 (BNL-4997) NANOSECOND COUNTER CIRCUITS. R. Sugarman and W. A. Higinbotham (Brookhaven National Lab., Upton, N. Y.). 22p.

A number of circuits using transistors and tunnel diodes were designed during the past year for counter experiments at pulsed accelerators. The circuits include coincidence circuits, pulse limiters, pulse amplitude discriminators, pulse amplifiers, fanout circuits, trigger circuits, and fast scalers. These individual units are compatible with each other in that the output of any one may serve as the input to another, and all interconnecting cables are 50 Ω impedance. They are designed to work with both small and large photomultiplier pulses. Two related developments are also presented. One is a high voltage supply for use with high-current photomultipliers. The other is a pulse train generator and synchronizing circuit, the combination of which is used for duty cycle tests. (auth)

9004 (BNL-5037) GATING UNIT. H. J. Foelsche (Brookhaven National Lab., Upton, N. Y.). Aug. 23, 1960. 9p.

A fast gating unit was built and has undergone preliminary testing. Operation of the unit is indicated, and the most significant test results obtained so far are reported. (W.D.M.)

9005 (CF-59-12-98) MODIFICATION OF A BAUSCH AND LOMB SPECTRONIC 20 COLORIMETER-SPECTROPHOTOMETER FOR IN-LINE APPLICATIONS. T. M. Gayle (Oak Ridge National Lab., Tenn.). Dec. 29, 1959. 14p.

Modifications included redesigned electronic circuitry to provide a d-c output signal for recording purposes, together with various mechanical changes to accommodate the flow cells. The modest initial cost of the original instrument and the relatively minor modifications needed for in-line use make this unit attractive for laboratory and certain pilot-plant applications. Accuracy and stability to 1% of full scale with sensitivity to 0.3% of full scale are obtainable. (auth)

9006 (CF-60-10-62) INSTRUMENTATION AND CONTROLS DIVISION, ELECTRICAL DESIGN STANDARDS AND GRAPHICAL SYMBOLS. A. E. G. Bates, M. M. Bowelle, J. L. Horton, R. L. Moore, R. F. Hyland, and C. Brashear (Oak Ridge National Lab.). October 1960. 83p.

Recommendations of the Instrumentation and Controls Division Committee on Electrical and Electronic Symbols and Drawings are presented. The American Standards Association Graphical Symbols for Electrical Diagrams are given, with certain variations or additions recommended by the Committee to clarify or more positively identify the device or element symbolized. Recommendations regarding electrical elementary diagram layout, device coding, etc., are included. (W.D.M.)

9007 (CF-60-11-96) DESIGN AND DEVELOPMENT OF A HIGH-TEMPERATURE HIGH-PRESSURE SPECTROPHOTOMETER SYSTEM: STATUS REPORT. R. E. Biggers and R. G. Wymer (Oak Ridge National Lab., Tenn.). Nov. 12, 1960. 25p.

Progress is reported on the design and development of a high-temperature high-pressure spectrophotometer system that is based on the Cary Model 14PM Spectrophotometer. (J.R.D.)

9008 (DP-140) MIXER-SETTLER DEVELOPMENT—OPERATING CHARACTERISTICS OF A LARGE-SCALE MIXER-SETTLER. Thomas J. Colven, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Oct. 1956. Decl. Mar. 28, 1960. Contract AT(07-2)-1.

A pump-mix mixer-settler was demonstrated to have an over-all efficiency greater than 90% for the extraction of $UO_2(NO_3)_2$ from TBP at total flow rates up to 45 gpm. Phase separation was satisfactory at 45 gpm, at which flow rate the residence time in the settlers was $1\frac{1}{2}$ min. It appeared possible that a throughput approaching 60 gpm would be operable although at an over-all efficiency of less than 90%. The tests were made on a three-stage unit, but the data can be extrapolated to multistage units. The effects of design of the impeller and mixing section, impeller speed, flow rates and ratios, and operating temperatures were studied. The mechanical performance and dependability of the unit were excellent. (auth)

9009 (DP-508) PLUTONIUM MONITOR FOR PUNCTURE WOUNDS. George H. Gruber (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Dec. 1960. 12p. Contract AT(07-2)-1.

Design details and operating characteristics are given for an instrument that can detect as little as 0.015 μg of Pu^{239} within puncture wounds. Scintillation techniques make it possible to count Pu^{239} x rays with a single-channel pulse-height selector. (auth)

9010 (HEPL-104) DESIGN CONSIDERATIONS FOR MAGNETIC SPECTROMETERS. John F. Streib (Stanford Univ., Calif. High-Energy Physics Lab.). Nov. 1960. 111p. Contract N6onr-25116.

Sponsored by AEC and ONR.

Results of an investigation aimed at reducing the size and cost of magnetic particle spectrometers are presented. A general form for the mathematical theory of image formation and momentum resolution in strongfield spectrometers is included, along with an examination of economic aspects of spectrometer development. It is concluded that a two-section spectrometer, having first a diverging field (in the plane of symmetry) and then a converging field, would in many cases be an economical arrangement. A quantitative study of a representative family of such patterns in which the two sections are adjacent and sufficiently extended to contain the source and detector is included. (J.R.D.)

9011 (HW-62449) PORTABLE DOSE-RATE INTEGRATOR—MARK I. A. N. Iverson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 27, 1960. 21p.

A portable solid-state electronic dose-rate integrator was designed, fabricated, and tested. The integrator is composed of a unijunction transistor oscillator, a monostable switch, and a register driver circuit. A total of five transistors are employed in this unit, and these transistors are encapsulated in three small replaceable modules. The circuits drive a single counting register that indicates total dose to the nearest tenth of 1 mr. (auth)

9012 (ISC-1175) AN ION SOURCE FOR MOLECULAR EFFUSION STUDIES. Don Merrill Jackson and D. E. Hudson (Ames Lab., Ames, Iowa). May 1959. 86p.

An ion source which utilizes a beam of monoenergetic electrons as the ionizing agent was designed and built for a 60°-sector general-utility mass spectrometer. The source was made for use without a magnetic field to collimate the electron beam. The source is interchangeable with a surface ionization source that was already utilized in the mass spectrometer. Various operating characteristics of the source were obtained, and the source was tested for linearity. If the source was perfectly "linear," the recorded ion current would be directly proportional to the atom current effusing into the ionizing region of the source. The source was estimated to be linear to within 1%. Latent heats of sublimation of silver and thulium were obtained with the source in the spectrometer. At 298°K a value of 70.2 ± 0.7 kcal/mole was found for silver and 57.7 ± 0.8 kcal/mole was found for thulium. (auth)

9013 (KAPL-M-PLE-3) SELF-CALIBRATING THERMAL NEUTRON COUNTER. P. L. Eisenacher (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 14, 1960. 13p. Contract W-31-109-Eng-52.

The feasibility of making a useful thermal-neutron counter with a built-in test source was demonstrated by fabricating and testing a BF_3-filled counter that contained 1 to 2×10^{-9} g of americium. The counter had normal operating characteristics and sensitivity and a steady background of 100 cycles/sec. The background pulse-height spectrum was continuous over approximately twice the range of amplitudes of pulses formed by neutrons, yielding certain restrictions and potential benefits. It is concluded that the manufacture and use of source-containing counters are entirely practicable. (auth)

9014 (MURA-436) DESCRIPTION OF A FUNCTION GENERATOR. D. A. Swenson (Midwestern Universities Research Assn., Madison, Wis.). Nov. 7, 1958. 9p. Contract AT-(11-1)384.

A description is given of a function generator designed to generate a wide variety of voltage waveforms. The waveform is produced as a voltage on a capacitor. The capacitor is charged by currents from "elementary" charging circuits. The charging currents are turned on and off by transistors that act as switches. A block diagram is given for the function generator, and a few typical elementary charging circuits are described. (auth)

9015 (MURA-444) ON THE SPIRAL ORBIT SPECTROMETER. L. Jackson Laslett (Midwestern Universities Research Assn., Madison, Wis.). Jan. 27, 1959. 17p.

The characteristics of orbits in the median plane of a spiral orbit spectrometer are briefly examined from the viewpoint of phase-plots similar to those used in accelerator theory. The characteristics of the spiral orbit spectrometer may be suggestive of injection methods that would prove useful in accelerator design. (auth)

9016 (NAA-SR-Memo-5208) PERSONNEL COUNTER. R. M. Kramer (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 29, 1960. 8p.

Studies were made to devise an inexpensive instrument to monitor a given area to preclude the possibility of reactor start-up with personnel in the reactor area. The instrument is to be used to monitor the entrance to the reactor core at the KEWB facility. The circuit developed is shown and operates on the principle of photoelectric switching which sets up a sequence to govern the number of light beam interruptions and also the direction of travel of the object interrupting the light beams. (W.L.H.)

9017 (NAA-SR-Memo-5420) SOME INFORMATION CONCERNING THE KEWB "B" WITH REGARD TO UCRL INSTRUMENT CALIBRATION. P. Spiegler (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 20, 1960. 13p.

The use of KEWB-B as a calibration source for pulse detection instruments is proposed. As a result, more information was needed: radial and axial distributions of fissions, number of fissions seen by the detection instruments, and materials seen by the detection instruments. The calibrations were achieved in six transient runs. (T.R.H.)

9018 (NAA-SR-Memo-5690) INVESTIGATION OF UNIFORMITY OF COUNTING EFFICIENCY AS A FUNCTION OF RADIAL POSITION IN SCINTILLATION COUNTERS. L. S. Beller and E. A. Moore (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 13, 1960. 12p.

An investigation is presented of a counter for low-energy gamma-scintillation pulse-height measurements in which the counting efficiency is a constant function of radial position for radii ≤ 0.3 in. Three counters meeting the immediate requirements were built, tested, and used in resonance escape and fast-effect measurements. The method uses a light-pipe arrangement that may improve the uniformity of light collection and concentrates the light on a relatively small portion of the photocathode over which the quantum efficiency is relatively uniform. This was done at the expense of poorer pulse-height resolution and over-all efficiency. (W.L.H.)

9019 (NAA-SR-Memo-5819) MEASUREMENT OF RESISTIVITY AND HEAT CAPACITY OF METALLIC CONDUCTORS. R. A. Finch (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 25, 1960. 26p.

An a-c potentiometric bridge method was developed to measure resistivities of metallic conductors from liquid nitrogen to 2000°K. Data are presented for tantalum, molybdenum, rhenium, zirconium carbide, and zirconium hydride. An electronic-pulse heating method is also described which allows the measurement of heat capacity of a conductor from liquid nitrogen to its melting point in a few milliseconds. A fast-response thermocouple was developed for use in the electronic-pulse heating apparatus. This thermocouple is capable of following temperature changes of 14,000°C/sec. (W.L.H.)

9020 (NP-9772) SINGLE-SCATTERING DENSITY GAUGE. Record of Invention No. 13. B. W. Schumacher (Canada. Ontario Research Foundation). Oct. 5, 1959. 9p.

A density gage especially suited for the very low density ranges is reported. The gage measures the singly scattered particles from a beam. The principle design of the gage is shown. The gage has two main parts: a point source of electrons, positrons, or α particles, and one or more pin-hole apertures. A fine narrow beam of particles is defined by the source and pin-hole aperture. This beam is passed down through the center of a thin-walled tube. The tube is surrounded by an ionization chamber. If it is assumed that no gas is present in the tube, the particle beam would pass through the tube and not one of the particles would strike or penetrate the wall of the tube. The count rate would be zero for zero gas density. (W.L.H.)

9021 (NYO-9402) NUCLEAR TRACK IMAGE INTENSIFIER. Quarterly Report No. 2, September 1, 1960 to November 30, 1960. R. D. DesRochers, H. A. Stern, and L. A. Ezard (Radio Corp. of America. Electron Tube Div., Harrison, N. J.). Dec. 30, 1960. 40p. Contract AT(30-1)-2591.

The design of the nuclear track intensifier was further analyzed to compare performance with design objectives. A preliminary analysis of the electron optics showed that the tube design suffers a small degree of astigmatism, which is increased in actual tubes by misalignment of parts. One tube was successfully completed and tested. Transit time of electrons from cathode to screen was determined to be 2.5×10^{-8} sec, $\pm 0.5 \times 10^{-8}$ sec. Decay characteristics of several standard phosphors were measured. In the phosphor development phase, a latin square test was designed to evaluate combinations of thallium-activated rubidium iodide and cesium iodide phosphors under various evaporating conditions. Data were taken on various tests and analyzed statistically. On target samples submitted for tube evaluation, a reaction, which reduced light output, occurred between the aluminum and phosphor during vacuum bake. One image tube prepared with an alkali iodide mixture showed 10 to 25% improvement in screen resolution as compared to a P-11 screen. (For preceding period see NYO-9401.) (auth)

9022 (ORNL-2773) THERMOCOUPLE RESEARCH TO 1000°C—FINAL REPORT, NOVEMBER 1, 1957—JUNE 30, 1959. J. F. Potts, Jr. and D. L. McElroy (Oak Ridge National Lab., Tenn. and Tennessee. Univ., Knoxville). 159p. Contract W-7405-eng-26, Subcontract No. 1072.

The basic cause-effect relations for thermocouple behavior were studied. Results of detailed investigations are reported on the consistency of temperature measurement standards from 0 to 960°C; the oxidation of commercial and special thermoelements and the accompanying calibration changes; the physical properties, such as cold-working, recovery, and recrystallization, and their effects on calibration; and the specific performance of commercial thermocouples as influenced by time and temperature of operation. In addition, a number of diagnostic short-range tests are reported. (auth)

9023 (ORNL-3001) INSTRUMENTATION AND CONTROLS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JULY 1, 1960. (Oak Ridge National Lab., Tenn.). Feb. 3, 1961. 114p. Contract W-7405-eng-26.

The design of a Q-2110 remote electrometer head is reported. The design of a Q-2114 electrometer is reported for a radiation-background monitor that will give an alarm or control signal at a predetermined level with an accuracy that can be achieved only with a stable linear-type instrument. A portable, transistorized, α scintillation counter was designed for the purpose of detecting low-level α contamination on hands, clothing, lunch counters, and other places where contamination could be a health hazard. The design of a metal-identification meter, Model Q-2076,

is reported. The instrument identifies metals by comparison with known samples. A transistorized, portable, single-channel γ analyzer for airborne monitoring is described. Production designs were completed on a high-gain, low-noise, linear pulse amplifier for use with Frisch-grid ionization chambers in α-particle spectrometers. A personal radiation monitor is described that gives both visible and audible warning signals. Gold–silicon surface-barrier counters that give good resolution at room temperature were made. A large-area α-survey probe was designed for surveying areas of low α contamination. Zener-diode regulated power supplies are described for Minneapolis-Honeywell and Leeds and Northrup recorders. Instrument flowsheets are shown for the 30-Mw cooling system of the Oak Ridge Research Reactor. Modifications are shown for a Bausch and Lomb Spectronic-20 colorimeter-spectrophotometer for in-line applications. Instrumentation for the salt-field experiment in the Cary Salt Co. mine is described. A status report is given on automatic experimental data handling and computation at ORNL. Instrument and controls development for the Homogeneous Reactor Project is reported. Performance tests are reported on ORNL fast safety system for pool-type reactors. (W.L.H.)

9024 (ORO-360) MASS SPECTROMETRY INSTRUMENTATION. ANNUAL PROGRESS REPORT. (Arkansas. Univ., Fayetteville. Dept. of Chemistry). Mar. 1, 1958. 69p. Contract AT(40-1)-2123.

Design and construction of an RF mass spectrometer for use as a testing instrument in the various phases of an investigation of ion sources are ~80% completed. Sufficient tests were made on electron multiplier assemblies to indicate the feasibility of exciting these units with an ultraviolet light source and using the resulting amplified electron current for operation of a mass spectrometer. A literature search is being made to find useful photocathode materials for the electron multiplier assembly. The gas interference effects originating in the ion source of an RF mass spectrometer are being investigated. A precise mathematical treatment was developed for an ion traveling through an analyzer stage in the RF mass spectrometer. (W.L.H.)

9025 (SC-4462(RR)) DESIGN AND CONSTRUCTION OF A UNIT FOR MEASURING METAL SKIN TEMPERATURES. PHASE II. LABORATORY INVESTIGATION AND CONSTRUCTION OF DEVELOPMENT MODELS. Period covered: May 1956 through November 1956. (Detroit Controls Corp., Redwood City, Calif.). Jan. 1961. 26p. For Sandia Corp.

Experimental work leading to the construction of twelve sample temperature-sensing units for installation in thin metal sections is described. These units are designed to measure surface temperatures and in-wall temperatures at various depths. Construction involved development of a technique of embedding platinum and platinum-10% rhodium thermocouples in SAE 4130 steel and 61ST aluminum by encasing the junction in the nugget of a resistance spot weld. Location of the thermocouple junction in the aluminum units was controllable within ±0.003 in.; in some of the steel units, shifting of the thermocouple wires during formation of the weld made maintenance of this tolerance difficult at all times. Electrical insulation of the thermocouple leads of the steel units was accomplished by cataphoretic deposition of alumina, and of the aluminum units by anodizing the inside diameter of the holes of the aluminum plate. The electrical output of the units is equal to that of a standard platinum and platinum-10% rhodium thermocouple. A cement of litharge and glycerine can be used as a satisfactory sealing compound to prevent gas leakage between the threads of the unit and the skin in which it is mounted. The aluminum and steel units should be able to withstand pressures of 400 psi across the skin at temperatures equal to or less than 400 and 850°C, respectively. The thermocouple output indicates the temperature at the point where the thermocouple wires last contact the aluminum or the steel prior to separation by the respective insulation coatings of anodizing or cataphoretic-deposited alumina. (auth)

9026 (SC-4521(RR)) SALTON SEA METEOROLOGICAL INSTRUMENTATION TEST SERIES, SALTON SEA, CALIFORNIA CONDUCTED IN SEPTEMBER 1959. L. E. Jones, R. L. Levesque, Jr., E. D. Niper, and John T. Willis (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 127p.

Tests conducted to determine the accuracy of meteorological equipment used to gather upper-air data are discussed. Equipment tested was the GMD-2, SMD-1A, GMD-1B, and the WBRT-57. A four-station phototheodolite network was used as a standard for point-in-space determinations. (auth)

9027 (TID-6915) THE CORRECTION OF SIGNALS DISTORTED BY LINEAR APPARATUS. C. P. Flynn (Illinois. Univ., Urbana. Physics Research Lab.). September 1960. 25p. Contract AT(11-1)-67, Project No. 3.

In a previous paper (Flynn and Seymour, Proc. Phys. Soc., 74: 337 (1960)), a technique was developed whereby a type of distortion produced by linear apparatus could be corrected rapidly and efficiently to obtain a "true" output signal. The distortion considered was not the most general linear distortion, and several cases of practical importance were therefore excluded. The general linear distortion is examined and equations developed which permit the rapid correction of distorted output signals into those to be anticipated from the use of ideal apparatus. The procedure is illustrated by means of an example. The accuracy of the corrected signals is then discussed, and it is shown that in some apparatus, as for instance, the magnetic resonance spectrometer, predictable optimum conditions occur under which the form of the true output signal may best be determined. Finally the response of the chain of linear units is treated with a view to the correction of the shape and moments of output signals from an apparatus whose resolving power is limited by several independent sources of distortion. (auth)

9028 (TID-6997) RESEARCH AND INVESTIGATION LEADING TO METHODS OF GENERATING AND DETECTING RADIATION IN THE 100 TO 1000 MICRON RANGE OF THE SPECTRUM. Quarterly Report No. 18 [for] June 1, 1960–September 1, 1960. P. D. Coleman, Jack R. Baird, Basil Hakki, and Joe Stafford (Illinois. Univ., Urbana. Electrical Engineering Research Lab.). Oct. 1, 1960. 15p. Contract AT(11-1)-392.

Progress is reported on submillimeter wave generation and submillimeter self-excited oscillators. (T.R.H.)

9029 (TID-11111) A KAPITZA TYPE NICKEL CADMIUM BATTERY. Eighth Quarterly Report (Final) April 1957–July 1957. (Gould-National Batteries, Inc., St. Paul). [nd]. 18p. Contract AT(30-1)-1831.

The life of individual test cells was very low when discharged to zero volts on each cycle, but addition of lithium to the electrolyte increased life to over 1000 cycles. The mechanism of lithium improvement of NiO_2 film stability is not known. Equalizing cell capacities by overcharging was studied and it was found that a considerable overcharge improves poor cells faster than the good cells. (T.R.H.)

9030 (TID-11148) APPLICATIONS OF TUNNEL DIODES IN SWITCHING CIRCUITS, REPORT NO. 102.

Toshiro Kunihiro (Illinois. Univ., Urbana. Digital Computer Lab.). Oct. 26, 1960. 59p. Contracts Nonr-1834(15) and AT(11-1)-415.

Asynchronous circuits using tunnel diodes were investigated, and circuit feasibility was clarified. Some experimental data were obtained. Since tunnel diodes are not carrier band devices but base band devices in their nature, the study of constructing asynchronous systems should be as successful as the study of synchronous systems. An attempt was made to design a memory array of tunnel diodes. (W.L.H.)

9031 (TID-11538) STRATOSPHERIC ELECTROSTATIC PRECIPITATOR. Summary Report, covering Period to June 1, 1960; Progress Report No. 1, June 1–July 31, 1960; Progress Report No. 2, August 1–September 30, 1960; Progress Report No. 3; October 1–November 30, 1960. (Del Electronics Corp., Mount Vernon, N. Y.). Contract AT(30-1)-2363. 42p.

A summary is presented of work conducted on an electrostatic stratospheric dust sampler for small particles. The theoretical considerations include particle dynamics, particle charging mechanisms, and a prototype precipitator design. Investigations were carried out on: (1) an experimental evaluation system; (2) flow tests with Millipore filters; (3) aerosol generation; and (4) precipitator efficiency tests. Descriptions are given of mass analyses of the dust samples using colorimetric, conductometric, and fluorescence techniques. Preliminary evaluation tests indicated that the experimental precipitator was capable of providing 90% collection efficiencies at 95,000 ft for small uranine particles. (B.O.G.)

9032 (UCRL-6184) CLOSE-IN PRESSURE MEASUREMENTS WITH TOURMALINE CRYSTALS ON TAMPED DETONATIONS. William F. Lindsay, Myron Heusinkveld, Alfred E. Villaire, and Otto H. Krause (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 7, 1960. 81p. Project COWBOY.

A series of experiments was conducted in Phase II of Project Cowboy in which tourmaline crystal transducers, located at 3 to 50 ft from tamped high-explosive detonations, detected dynamic elasto-plastic stress waves generated in salt. The detonations occurred 110 ft below the 800-ft working level of the Carey Salt Mine, near Winnfield, Louisiana. These experiments were designed to measure dynamic stress conditions resulting from explosions in earth media, of which little is known at present, and to provide data for comparative calculations on seismic disturbances from tamped explosions and from explosions in large underground cavities. Elastic stress waves of 1 kilobar magnitude were observed with velocities of about 15,000 ft/sec. Inelastic stress waves up to 6 kilobars in magnitude were measured. Velocities for these waves were in the range 9000 to 12,000 ft/sec. (auth)

9033 (UCRL-9475) DATA PROCESSING FOR BUBBLE CHAMBERS. Howard S. White (California. Univ., Berkeley. Lawrence Radiation Lab.). Nov. 10, 1960. 22p. Contract No. W-7405-eng-48.

The computer program that performs spatial reconstruction of events photographed in a bubble chamber is required to eliminate human and digitizer errors. It recognizes and corrects for single nuclear scatterings in the presence of multiple Coulomb scatterings; these, if left undetected, would lead to false estimates of the momenta and angles of tracks. Momentum components are determined and kinematic constraints are applied. Measured parameters are transformed into special reference frames, and quantities of physical interest are calculated. Results are stored in a tape file containing all events of one reaction type. Data are obtained as page output for each event and CRT displays of selected parameter distributions for all events. (auth)

9034 (UNM-PR-EE-15) INDUCED VOLTAGE IN THE HALL GENERATOR. Laurence L. Rosier (New Mexico. Univ., Albuquerque. Engineering Experiment Station.). Apr. 8, 1960. 9p. For Sandia Corp. (SCDC-2177).

If the Hall generator is to be used in conjunction with a time-varying magnetic field, the effect of induced voltage must be considered. Theoretical and experimental investigations are reported. (W.L.H.)

9035 (WADD-TR-60-563) DOSIMETRY BY LUMINESCENCE DEGRADATION IN ORGANICS. Frank H. Attix (Naval Research Lab., Washington, D. C.). Oct. 1960. 65p. Project No. 7360. Contract AF MIPR(33-616)-58-21.

An investigation is presented of the phenomenon of photoluminescence degradation in organic materials due to damage by ionizing radiations. A survey of previous studies of this effect is presented. The present work stresses reduction to a practical dosimetry system for the 5×10^5 to 5×10^9 rad absorbed dose range. It is demonstrated that pressed wafers of anthracene and of p-quaterphenyl can be employed together to cover the required dose range. Ultraviolet light (3650 A) is used to excite the photoluminescence, which is observed in a narrow band at 4420 A. Some recovery of photoluminescence with time after x-ray irradiations is observed, and heat treatment is proposed as a method of reducing this effect. Degradation of luminescence in biphenyl, p-terphenyl, fluorene, naphthalene, and tetracene have also been studied and are reported on. (auth)

9036 (WT-1535) INSTRUMENTATION OF FRENCH UNDERGROUND SHELTERS (PROJECT 30.6). J. J. Meszaros and J. G. Schmidt (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Jan. 24, 1961. 126p. Project 30.5b of OPERATION PLUMBBOB.

A total of five structures was instrumented. Instrumentation and installation procedures are described. Phenomena for which data were obtained included deformation and acceleration, thermal radiation and temperatures, overpressures, and nuclear radiation and contamination. The results obtained are listed and analyzed. (auth)

9037 (CEA-tr-A-840) UN TUBE GÉNÉRATEUR DE NEUTRONS ENTIÈREMENT SCELLÉ. (On Generation of Neutrons in Completely Sealed Tubes). O. Reifenschweiler and A. C. Van Dorsten. Translated into French from Physik. Verhandl., 8: No. 7, 163(1957). 10p.

A small neutron generator is described in which the ion source and ion accelerator operate at the same gas pressure, about 10^{-3} mm Hg. The structure of the generator is similar to that of an x-ray tube. Deuterons produced in a Penning ion source are accelerated to 125 kev by a single-stage system, and then directed on a T_2 target where they produce 14-Mev neutrons. The pressure of the gas in the tube is maintained constantly during operation by means of a zirconium filament saturated with D_2 and heated. Up to 5×10^7 neutrons/sec are obtained. (tr-auth)

9038 (HW-tr-22) LIMIT TO THE MEASUREMENT OF LOW ACTIVITIES WITH IONIZATION CHAMBERS. M. Briere. Translated by Liz Appleby (Hanford Atomic Products Operation) from Report CEA-942, 1958. 30p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 5325.

9039 (SCL-T-341) MEASURING DIVIDERS FOR SURGE (PULSE) VOLTAGES. PART II. THE CAPACITANCE DIVIDER. (Messteiler für hohe Stoss-Spannungen. Teil II. Der Kapazitätsteiler). Wilhelm Raske. Trans-

lated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.). from Arch Elektrotech. 31, 732-48(1947). 25p.

Measuring errors of the capacitance divider when applied to pulse voltages are calculated. Measurement of the potential in models of the capacitance divider is discussed. An internal capacitance divider whose measuring range can be varied from the outside by means of an electromagnetically adjustable iris shutter and high-voltage cathode-ray oscillograph are described, including the divider, the measuring deflection system, the high-voltage lead-in, and the high-voltage chamber of the latter. (C.J.G.)

9040 (SCL-T-347) EXCERPTS FROM PROPERTIES AND APPLICATIONS OF METAL MEMBRANES. (Eigenschaften und Anwendungen von Metallmembranen). E. Wintergerst and H. Lintz. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.) from Regelungstech. 7, 160-5(1959) May. 10p.

The calculation of dimensions of metal diaphragms for use in pressure-measuring devices is discussed. The well-known formulas are briefly reviewed; approximate methods for calculations on concentrically undulated diaphragms are treated more fully. Empirical values and examples of their application are included. (D.E.B.)

9041 (UCRL-Trans-455) INVESTIGATION OF THE SWELLING CAPACITY OF ILFORD G-5 AND NIKFI TYPE-R PLATES. V. M. Uvarova and N. V. Anosova. Translated from Trudy Vsesoyuz. Nauch.-Issledovatel'. Kinofotoinst. No. 11 (21), 43-8(1957). 6p.

The swelling of Ilford G-5 and NIKFI-R plates was studied in different solutions. The anomalous swelling capacity of the emulsion layer of G-5 plates in comparison to gelatin layers was established. This emulsion layer swelling is analogous to that of gelatin-polyvinyl layers, as well as to layers with high concentrations of surfactants. The production of layers with low swelling in acid media is more promising than reduction of deformation during processing. (T.R.H.)

9042 MODIFICATION OF AN IONIZATION CHAMBER GAS-LIQUID CHROMATOGRAPHY INSTRUMENT. B. Theodore Cole (Oak Ridge National Lab., Tenn.). Anal. Chem., 33: 317-18(Feb. 1961).

An ionization chamber gas-liquid chromatographic instrument had to be modified to keep the solvent in a vapor phase throughout the length of the column until it condensed on the appropriate coil. This additional heat was provided by tightly wrapping the tubing housing the column with two 30-in. 450-w units equipped with asbestos leads. The voltage to each unit was independently controlled. The shape of the elution peak was found to be strongly influenced by the manner in which the sample was introduced. Metal and glass injection assemblies are described. (M.C.G.)

9043 CHARACTERISTIC PARAMETERS OF GAS-TUBE PROPORTIONAL COUNTERS. I. METHANE, METHANE-ARGON, AND ETHANOL-ARGON COUNTERS. Robert W. Kiser (Kansas State Univ., Manhattan). Appl. Sci. Research, B, 8: 183-200(1959).

The gas multiplication factor A_0 was determined in cylindrical counters at specific counter wire voltages and varied pressures, wire radii and counter shell radii for methane and various methane-argon mixtures, as used in proportional counters. It is seen that the Rose-Korff and the Curran-Craggs-modified Rose-Korff theory do not agree with the experimental results. Use of the Diethorn expression is made in presenting the results in terms of two parameters $\overline{\Delta V}$ and $\overline{K}$, characteristic of the gas filling. The meaning and values of $\overline{\Delta V}$ and $\overline{K}$ are discussed, and the recent results of van Duuren and Sizoo for an ethanol-argon mixture are reinterpreted in terms of these characteristic parameters. (auth)

9044 CHARACTERISTIC PARAMETERS OF GEIGER-MÜLLER COUNTER GASES. I. ETHANOL-ARGON MIXTURES. Charles D. Storrs and Robert W. Kiser (Kansas State Univ., Manhattan). Appl. Sci. Research, B, 8: 387-96 (1959).

The Wilkinson and the Diethorn-Kohman expressions of counter operation are reviewed. In equating these two expressions, the gas amplification factor is taken to be 10^7 at the starting potential for Geiger operation of the counter. Although the use of this numerical value has not yet been completely verified, the use of a constant is established from the results obtained for the five different ethanol-argon mixtures examined in this work. The variation of the characteristic parameters with gas composition is shown to be in general accord with the theory being formulated. (auth)

9045 AUTOMATIC COUNTING SYSTEMS FOR NUCLEAR PHYSICS MEASUREMENTS. G. Colombo, E. de Agostino, and U. Pellegrini. Automazione e strumentazione, 5: 195-8(1960). (In Italian). (CNEN-9)

A survey is made of automatic counting systems used nowadays in nuclear physics tests. In particular a transistor two-cycle timer for prefixed time measurements is described, as well as electronic equipment annexed to the crystal spectrometer for Ispra-1 reactor, permitting the programming of an entire series of measurements, both by number and by predetermined time. (auth)

9046 RADIATION CONTROL APPARATUS. M. Dieval. Bull. inform. sci. et tech. (Paris), No. 43, 10-23(Sept. 1960). (In French)

The necessity of guarding workers in nuclear energy plants and the general population against radiation exposure requires the following health and safety precautions: measurement of the accumulated radiation exposure of workers, measurement of the intensity of radiation at various points in an installation, and verification of the radioactive contamination of surfaces, the atmosphere, and water. A brief survey is given of instruments designed for the detection and measurement of radiation levels and for the detection and measurement of contaminations. (J.S.R.)

9047 THE SPECIFIC FLUORESCENCE OF PLASTIC SCINTILLATOR NE102. J. R. Prescott and A. S. Rupaal (Univ. of British Columbia, Vancouver). Can. J. Phys., 39: 221-7(Jan. 1961).

The quenching parameter kB in the equation for the specific fluorescence $dS/dx = A(dE/dx)/[1 + kB(dE/dx)]$ was determined for a number of different samples of plastic scintillator NE102. Gamma rays and α particles were used, and for one sample a check using recoil protons from neutron collisions was made. The α particle runs gave a kB value of 0.0095 ± 0.0008 cm plastic/Mev (0.0098 ± 0.0006 g/cm^2 Mev), while the recoil proton run gave a kB value of 0.0088 ± 0.0006 cm plastic/Mev (0.0091 ± 0.0006 g/cm^2 Mev). It is believed that the latter result is more reliable than the one obtained with α particles. Both are in agreement with the data of Evans and Bellamy, but Daehnick and Fowler's low results remain unexplained. (D.L.C.)

9048 HIGH TRANSMISSION BETA-RAY SPECTROMETER. Zdenek Plajner and Vlastislav Brabec (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Ceskoslov. časopis pro fysiku, 10: 115-21(1960). (In Czech.)

An intermediate image beta-ray lens spectrometer of

the Siegbahn-Slätis type is described. A study was made of the focusing quality at different settings of the variable parameters. The instrument is intended for studying beta spectra, the spectra of conversion electrons, and photospectra in regions up to 2 Mev. It attained a maximum resolving power of 1.2% at a source diameter of 2 mm. The maximum transmission was 8%. (auth)

9049 PHOTOLUMINESCENT MULTIPLIER. Stanislav Koc and Radko Seidl (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Československ. časopis pro fysiku, 10: 223-4(1960). (In Czech.)

A radiation detector using a new principle of avalanche-like current growth is proposed. A description is given of the action of the detector, based on the cycle "emission of photoelectron → acceleration of photoelectron in electric field → incidence of photoelectron on anode with luminescent substance → emission of luminescent photon → incidence of photon on photocathode → emission of photoelectron." An alternative solution is also given which comprises a secondarily emitting intermediate electrode. The expected advantages of the new equipment are pointed out. (auth)

9050 PROPORTIONAL COUNTER OF THERMAL NEUTRONS FILLED WITH BF_3. Dušan Srnka (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Československ. časopis pro fysiku, 10: 288-93(1960). (In Czech.)

The construction of a proportional thermal-neutron counter and the preparation of BF_3 are described. The basic characteristics of these counters are given. The influence of electronegative impurities in BF_3 on the properties of the counter was also studied. (auth)

9051 APPARATUS FOR PERMANENT MEASUREMENT OF VARIATIONS IN INTENSITY OF COSMIC RAYS. I. Lehraus, P. Mokrý, and B. Slavík (Physical Inst., Czechoslovak Academy of Sciences, Prague). Československ. časopis pro fysiku, 10: 297-302(1960). (In Czech.)

A description is given of variations of the cubic telescope and neutron monitor, which were constructed according to the general regulations of CSAGI for measurements in the IGY program. The experience obtained with their long-term operation is discussed. (auth)

9052 TEMPERATURE DEPENDENCE OF SCINTILLATION DETECTORS. Jiří Skrivánek and Marie Veselá (UJV, Czechoslovak Academy of Sciences, Prague). Československ. časopis pro fysiku, 10: 312-15(1960). (In Czech.)

The temperature dependence of efficiency was measured for detectors with organic and inorganic scintillators. In the range from +5 to +40°C, the coefficients of the organic scintillators were negative, the dependence of NaI(Tl) on the temperature was reciprocal. The form of the amplitude spectrum of the scintillator ZnS(Ag) + paraffin did not vary with temperature. The temperature coefficients of RCA 6655- and 6342-type photomultipliers were negative in the range measured. (auth)

9053 DYNAMIC ELECTRON MULTIPLIER. Ladislav Kryška and Ludmila Eckertová (Charles Univ., Prague). Ceskoslov. časopis pro fysiku, 10: 420-4(1960). (In Czech.)

The construction of a dynamic electron multiplier is described. The results of measuring its basic characteristics are given. Conceptions as to the mechanism of processes in the multiplier are supplemented and an evaluation made of some of its properties in comparison with static multipliers. (auth)

9054 ON THE PROBLEM OF THE LIFETIME OF GEIGER-MÜLLER COUNTERS. Přemysl Mokrý (Physical Inst., Czechoslovak Academy of Sciences, Prague). Ceskoslov. časopis pro fysiku, 10: 526-9(1960). (In Czech.).

A description is given of a quenching circuit, and the manner in which the lifetime of Geiger-Mueller (GM) counters can be prolonged is discussed. Such quenching circuits were used in apparatus for measuring the variations in cosmic-ray intensity so that the number of exchanges of counters was lowered and the course of the changes in their properties was reduced, thus permitting the required measuring stability to be attained. Such circuits are of considerable economic importance because, in long-term operation, they decrease the number of G-M counters used at least ten times. The price of the necessary valves represents about 6% of the price of the counters. (auth)

9055 PRODUCTION OF CONTINUOUS VOLTAGES IN A TUBE WITH RAREFIED GAS EXCITED BY A HIGH FREQUENCY ELECTRIC FIELD. René Fouret and Roland Guillemard. Compt. rend., 251: 2317-19(Nov. 21, 1960). (In French)

The production of continuous voltage in a rarefied gas tube with an interior collecting electrode was studied. The effect of the position of the exciting solenoid with respect to the tube and the effect of the exciting voltage at the boundary of the induction coil were defined. It was determined that the polarity of the tube depends essentially on its position in the induction coil. (tr-auth)

9056 A CRYOSTAT FOR STUDYING TRANSURANIC SUBSTANCES. G. T. Meaden (Clarendon Lab., Oxford) and J. A. Lee. Cryogenics, 1: 33-6(Sept. 1960).

A cryostat used in conjunction with a glove box is described. Such an apparatus is suitable for measuring the electrical resistivity and Hall effect of strongly alpha-active metals and alloys over the temperature range 1.4 to 300°K. (auth)

9057 SOME ASPECTS OF NUCLEAR REACTOR CONTROL. EXPERIMENTAL ANALYSIS OF THE FUNDAMENTAL CONDITIONS OF PULSE AMPLIFIERS. L. Sani and F. Zanchi (Universita, Rome). Energia elettrica, 37: No. 3, 10p.(1960). (In Italian)

The operating conditions for linear pulse amplifiers as fundamental elements in the pulse counting chain are discussed. The numerous parameters involved in the operation of pulse amplifiers are analyzed, and the results obtained during the course of several laboratory experiments are given. The experiments included theory of operation. (T.R.H.)

9058 SOME ASPECTS OF NUCLEAR REACTORS CONTROL. EXPERIMENTAL RESEARCH ON THE PROPERTIES OF THE BORON TRIFLUORIDE PROPORTIONAL COUNTER. L. Sani and F. Zanchi (Università, Rome). Energia elettrica, 37: No. 7, 13p.(1960). (In Italian)

The importance of the BF_3 proportional counter in reactor control, particularly start-up and shut-down, is pointed out, and its characteristics are discussed in detail. The discussion begins with general considerations in detection of neutron flux by BF_3 counters and their sensitivity to neutrons. The discussion continues then with the gas multiplication factor, width of the voltage pulse at the counter output, and counting characteristics. Finally, collection time, γ sensitivity, and useful life of the BF_3 proportional counter are discussed. (T.R.H.)

9059 MEASUREMENT OF THE NEUTRON FLUX IN NUCLEAR REACTORS. Lajos Bata (Central Physical Research Inst.). Energia és Atomtech., 13: 326-33(1960). (In Hungarian)

In view of the importance of the exact knowledge of the neutron flux levels, for all reactor physics measurements, the experimental methods used in these determinations and their theoretical principles are discussed. Activation of foils of Au, In, Cu, and Mn is described together with the measurement of the absolute flux by β-γ coincidence. As γ-detecting systems, NaI crystal, a plastic phosphor containing paraterphenyl with a multiplier, or a β-multiplier with an anthracene crystal are considered. The measurements reported were made at the Hungarian VVRS type reactor, determining the axial and radial flux distributions. Cu^{64} wire was used as a thermal neutron detector, whereas, for the detection of intermediate level, neutrons I^{128} and Mn^{56} in a polystyrene layer were employed. (TTT)

9060 PROBLEMS PRESENTED BY THE LIQUID LEVEL DETERMINATION AND CONTROL BY MEANS OF RADIOACTIVE ISOTOPES. Janos Kakas (Radioisotope Lab. of the "Csepel" Iron and Metal Works, [Hungary]). Energia és Atomtech., 13: 502-6(1960). (In Hungarian)

In designing a detection system for determining the liquid level in closed vessels kept under high pressures, it appears desirable to place the source in the wall of the vessel itself in order to keep the activity of the source as low as possible, thus reducing the shielding requirements. For determining the maximum and minimum levels only, it is sufficient to use a single source with two identical G-M tubes. If a signal is detected by both tubes, the liquid is at the lower level—signal in 1 tube indicates an intermediate and no signal the top position. The tube should be able to discriminate between yes and no signals. For continuous measurements, the source is preferably placed at the side of the vessel near the lowest anticipated level. If a bulk source is used instead of a point source, the measurement is based on the shielding provided by the changing liquid column. (TTT)

9061 THE DISCHARGE CHAMBER DEVELOPED AS AN ALPHA PARTICLE DETECTOR. L. Colli, M. Fazio, and T. Rossini (Centro Informazioni Studi Esperienze, Milan and Università, Milan). Energia nucleare (Milan), 7: 865-6(Dec. 1960). (In English)

The design and operation of a discharge chamber, similar to a Wilson chamber, for the detection of low-energy α particles is described. The chamber consists of two flat parallel electrodes in a gas atmosphere (99% neon and 1% argon) at atmospheric pressure. A schematic diagram of the device is given. A pulsed voltage of 16 kv with a rise time of the order of 10^{-8} sec and a decay time of 10^{-7} sec is applied to the electrode. The instrument is very stable with reproducible results. (J.S.R.)

9062 A METHOD FOR CHARGED PARTICLES SELECTION. Nikola Cindro. Glasnik mat.-fiz. i Astron., Ser. II, 15: 113-18(1960). (In English)

A method is given for distinguishing between different charged particles as products of a nuclear reaction. It is based on the total energy loss and is suitable for singling out particles with the largest specific ionization, e.g., alpha particles. In this method, scintillation crystals are cut or evaporated to the thickness sufficient to stop particles of a given type and energy. A 270-mg/cm^2 NaI(Tl) crystal and a 20-mg/cm^2 CsI(Tl) crystal prepared in this way were used for the energy spectra of deuteron bombardment of aluminum at 15 Mev and the $O^{16}(n,\alpha)C^{13}$ reaction at 14.5 Mev, respectively. (D.L.C.)

9063 THE SENSITIVITY OF PHOTOGRAPHIC FILM TO 3-Mev NEUTRONS AND TO THERMAL NEUTRONS. Margarete Ehrlich (National Bureau of Standards, Washington, D. C.). Health Phys., 4: 113-28(Dec. 1960).

Measurements were made to determine the sensitivity to 3-Mev neutrons and to thermal neutrons of three commercial photographic films (DuPont film types 502, 510, and 606). The films were exposed in the conventional NBS holders, consisting of Bakelite covered with thin layers of lead and tin. The results of the measurements were compared with results obtained by rough theoretical estimates. The sensitivity of the films to neutrons was found to be relatively low. On the least sensitive film, a photographic density of 0.1 was obtained with a fast-neutron exposure of 6.8×10^{10} neutrons/cm^2. On the most sensitive film, the exposure for the same density was 4.9×10^9 neutrons/cm^2. The ratios of the films' fast-neutron-to-γ-ray sensitivities were found to be roughly equal to the reciprocal of the ratios of their average grain diameters. The thermal neutron sensitivity of the films was of the same order as the 3-Mev sensitivity, and was roughly the same for all three film types. In the few cases in which values for the neutron sensitivity could be obtained theoretically, they showed order-of-magnitude agreement with the experimental values. (auth)

9064 AUTOMATIC NUCLEAR EMULSION SCANNER. S. Becker (Airborne Instruments Lab., Melville, N. Y.). Health Phys., 4: 164-71(Dec. 1960).

An automatic nuclear emulsion scanner has been designed and constructed to scan the exposed film in personnel radiation monitoring badges. The scanner detects a portion of proton-recoil tracks in the film emulsion caused by incident neutron flux. The scanning speed, at present, is comparable with that of the visual reader and provides about the same statistics. The scanner uses a special closed-circuit TV camera system to view, scan, and count the proton-recoil tracks in a magnified image of a dark-field illuminated nuclear emulsion. The camera video signals are analyzed in a computer that uses two ultrasonic delay lines for signal storage. The computer discriminates against single grains, clumped grains, and unusual artifacts in the emulsion. Tracks are detected on the basis of their contrast against their background and their projected length in the emulsion. Field evaluation tests at Brookhaven National Laboratory indicate that the track count is a linear function of neutron flux. The spectral response curve of the scanner shows a proportionately greater track count at the higher energy levels. In addition, the scanner track count is fail-safe for moderate γ exposures. Operational characteristics of the automatic nuclear emulsion scanner are discussed. (auth)

9065 AUTOMATIC α-PARTICLE HAND COUNTER, MODEL HC-2. J. R. Mann (Dow Chemical Co., Denver). Health Phys., 4: 172-3(Dec. 1960).

The design and operation are described of a completely automatic personnel-operated α-particle hand monitor. The instrument indicates only that the hand contamination is above or below a predetermined level. A loudspeaker with adjustable volume may be attached where an aural indication of count rate is desired. (C.H.)

9066 RADIATION GLO-BAR—A DEVICE FOR THE DELINEATION OF A PRIMARY X-RAY BEAM. H. L. Goldman and S. Davies (New York State Dept. of Health, Albany). Health Phys., 4: 178-9(Dec. 1960).

During the course of radiation inspections and surveys of medical and dental X-ray units, one of the most serious defects found is the lack of proper collimation of the primary beam, causing much unnecessary and undesirable radiation to be delivered to the patient, and also causing increased amounts of scatter radiation to reach the operator. A satisfactory method to demonstrate the state of col-

limation is the "Radiation Glo-Bar." The "Radiation Glo-Bar consists of four arms, each 18 in long, emanating from a central hub, in the shape of a cross. A strip of fluorescent screen is imbedded throughout the length of each arm. The entire "Glo-Bar" can be attached to a cassette or a table top by means of a suction cup on the hub. Construction is of lucite. (D.E.B.)

9067 A SIMPLE FILM BADGE. V. Paić (Ruder Boskovic Inst., Zagreb). Health Phys., 4: 180(Dec. 1960).

A film badge is described in which the radiation filters serve also as support for the film. Persons exposed to γ rays or to thermal neutrons wear an appropriate dental film shielded on both sides by one cadmium and one tin filter. Persons exposed to β rays or to soft x rays wear a film shielded on both sides by an aluminum filter of the same thickness. (auth)

9068 THE METHANE DOSIMETER. Barry L. Tarmy, William Bartok, and Peter J. Lucchesi (Esso Research and Engineering Co., Linden, N. J.). Ind. Eng. Chem., 53: 147-50(Feb. 1961).

A convenient, accurate chemical technique was developed for radiation dosimetry based on the measurement, using gas chromatography, of hydrogen produced by the radiolysis of methane. The method is particularly suitable for dosimetry of vapor phase systems. The dosimeter was tested in both static and flow systems over a wide range of conditions, including γ, electron, and mixed neutron-γ radiation sources; radiation dose rates of 0.1 to 29 megarads per hour; temperatures from 24 to 204°C; and pressures from 1 to 42 atm. Up to 180°C the results obtained showed excellent precision and were within the accuracies of the iron(II)-iron(III) and calorimetric dosimeters used for comparison. The method is particularly suitable for dosimetry of vapor-phase hydrocarbon systems directly in the chemical reactor. (auth)

9069 A TWO-DIRECTIONAL FOCUSSING HIGH-INTENSITY MASS-SPECTROMETER. S. B. Karmohapatro (Saha Inst. of Nuclear Physics, Calcutta, India). Indian J. Phys., 34: 407-15(Sept. 1960). (In English)

A two-directional focusing high-intensity mass spectrometer of focusing angle $\sqrt{2}\pi$, with mean radius 381 mm and variable 20 kv accelerating voltage, is described. Focusing properties and performance with a magnetic oscillation type ion source for gases are studied so that the instrument may be useful for studies of collision of ions in gases and solids and for preparation of isotopic targets and β sources by the direct deposition method. (auth)

9070 ELECTRONIC INSTRUMENTATION IN NUCLEAR POWER PLANTS. II. R. Wahl. Inds. atomiques, 4: No. 9-10, 76-82(1960). (In French)

The evolution of nuclear instrumentation to computer control and automation is reviewed, and examples of this trend are presented. Coincidence selectors, amplitude selectors, multichannel amplitude selectors, and time-of-flight selectors are described. The measurements allowed by such instruments and centralization of results are considered. (J.S.R.)

9071 MEASUREMENT OF WEAK BETA ACTIVITIES. A. J. Duivenstijn (Maison Phillips, Eindhoven, The Netherlands). Inds. atomiques, 4: No. 9-10, 119-22(1960). (In French)

The utilization of anticoincidence apparatus for the measurement of low β activities necessitates the development of G-M tubes with a very great sensitivity for a small volume to be used as guard tubes. The design and construction of such a tube with semispherical cathode and filled with a mixture of neon and argon containing bromine are described. The complete radiation detection instrument with its lead shielding, detector tubes, and guard tubes is then discussed. (J.S.R.)

9072 A THREE-CHANNEL LOW-BACKGROUND COUNTING UNIT. D. Rowan and W. Stevenson (Western Regional Hospital Board, Glasgow). Intern. J. Appl. Radiation and Isotopes, 9: 120-2(Dec. 1960). (In English)

A three-channel low-background counting unit was constructed for measurements in the range 1 to 10 cpm on Sr^{90} and Y^{90} samples. The unit has three end-window counters mounted at the center of a cylinder formed by 16 screen Geiger tubes. The outputs of the end-window counters are fed into preamplifiers. The features of the unit are three-channel operation without interaction, continuous operation without adjustment of controls, and ease of sample presentation. Each sample is counted for 24 hr. The counting efficiency was found to be 33 to 43% for 0.01 mμ c Sr^{90} and ~20% for 0.02 mμ c Y^{90}. The background count rates of the unit at various stages of castle construction, with and without screening, are given. (D.L.C.)

9073 A SIMPLE PLASTIC SCINTILLATION COUNTER FOR TRITIATED HYDROGEN. I. S. Boyce, J. F. Cameron, and K. J. Taylor (Wantage Research Lab., Berks, Eng.). Intern. J. Appl. Radiation and Isotopes, 9: 122-3(Dec. 1960). (In English)

A plastic scintillation counter was designed and constructed for measuring the H^3 content of hydrogen emerging from a palladium chromatographic column. The counter consists of a piece of plastic phosphor shaped into a tube and inserted in the glass tubing leading from the column, with painted capillary tubing ends to exclude stray light. The sensitive volume of the detector is 0.5 ml, and a counting efficiency of 2.2% with a background of 5 c/sec at 20°C was obtained for tritiated hydrogen at 66 cm Hg. (D.L.C.)

9074 INFLUENCE OF THE HUMIDITY ON THE SPARK FORMATION IN ROSENBLUM COUNTERS. Lino Daddi and Luciano de Franceschi (Corso per le Applicazioni Mediche dell'Energia Nucleare, Leghorn). Intern. J. Appl. Radiation and Isotopes, 9: 132-3(Dec. 1960). (In English)

The effects of water vapor content of air on the efficiency of Rosenblum spark counters in air were studied using wire-rod counters and α particles from Po^{210}. The experiments were carried out in saturated air at various temperatures up to 56.2°C, corresponding to a water saturation pressure of 125 mm Hg. The results, plotted as counts vs. water vapor pressure and counts vs. applied voltage, show that water vapor increases the efficiency for both broad-side and end-on irradiation, indicating a spark mechanism of the streamer type. (D.L.C.)

9075 TRANSISTORIZED RADIATION MONITORING EQUIPMENT. J. J. Henry (Union Carbide Nuclear Co., Y-12 Plant, Oak Ridge, Tenn.). IRE Intern. Conv. Record, 8: Pt. 9, 28-33(1960).

A hermetically sealed all-transistor radiation monitor was developed to attain optimum accuracy and dependability in industrial applications. This equipment compares favorably with the better vacuum tube equipment. A cascade circuit linear amplifier, a linear base line pulse-height discriminator, and a pulse-width-modulated diode-switched constant-current rate meter circuit are employed. These circuits provide good linearity, stability, paired-pulse resolution of < 2 μsec, and no discernible zero drift. The circuits are designed for low power consumption and are hermetically sealed in a small corrosion-resistant case. Modular plug-in construction is used to aid maintenance. (auth)

9076 INTRODUCTION TO SEMICONDUCTOR PARTICLE DETECTORS. W. L. Brown (Bell Telephone Labs., Murray Hill, N. J.). IRE Trans. Nuclear Sci., NS-8: No. 1, 2-10(Jan. 1961).

The physical processes that govern the operation of semiconductor particle detectors are considered. Discussions are presented on: the production of hole-electron pairs by energetic particles in solids; the motion of the pairs under the influence of an electric field and in the presence of trapping and recombination; the current wave shape resulting from transport of these carriers; the production of high electric fields to facilitate transport in single conductivity and junction devices; and the influence of high densities of holes and electrons along particle tracks on the transport processes. (auth)

9077 EXPERIENCE AT HARWELL WITH SURFACE-BARRIER DETECTORS. G. Dearnaley (Atomic Energy Research Establishment, Harwell, Berks, Eng.). IRE Trans. Nuclear Sci., NS-8: No. 1, 11-16(Jan. 1961).

A simple and reliable technique for the construction of surface-barrier detectors of silicon and germanium is described. Their characteristics, sensitive depth, working life, and damage by radiation are discussed. Various structures of detectors were investigated, and their applications to nuclear physics are discussed. (auth)

9078 PERFORMANCE OF SILICON SURFACE BARRIER DETECTORS WITH CHARGE SENSITIVE AMPLIFIERS. J. L. Blankenship and C. J. Borkowski (Oak Ridge National Lab., Tenn.). IRE Trans. Nuclear Sci., NS-8: No. 1, 17-20(Jan. 1961).

Silicon surface-barrier diode detectors of 1 cm^2 and 25 mm^2 sensitive area gave pulse height spectral resolutions of 17 and 13.5 kev (FWHM), respectively, for 5.5-Mev α particles. Reverse currents at 500 volts bias were less than 1×10^{-6} amp/cm^2 with breakdown in excess of 1000 volts. A charge-sensitive amplifier contributed 3.5 and 10 kev noise (FWHM) with an input capacitive loading of 20 and 180 pf, respectively. (auth)

9079 HIGH RESOLUTION STUDY OF NUCLEAR REACTIONS BY p-n JUNCTION DETECTORS. G. Amsel, P. Baruch, and O. Smulkowski (Laboratoire de Physique de l'Ecole Normale Superieure, Paris). IRE Trans. Nuclear Sci., NS-8: No. 1, 21-8(Jan. 1961).

The specific problems which arise from the use of p-n junctions for the detection of particles emitted in nuclear reactions were studied. The mechanism which allows the distinction between particles of different nature emitted in nuclear reactions like (d,p), (d,α), and (d,d) is explained. Behind the barrier there was a "diffusion zone" which furnished a slow component to the pulse. Pulse-shape selection technics permitted elimination of pulses due to long-range particles. The diffusion zone was then used as an anticoincidence detector. Detectors in low-resistivity material were necessary for the detection of short-range particles. Inverse current increased rapidly with the ionic bombardment induced by the beam on the target. However, a simple electrostatic deflection system protected the junction. The energy of the emitted particles rapidly varied with the angle of observation. This led to the use of slit-shaped detectors for maximum resolution. Typical spectra obtained in course of the study of the reactions $O^{16}(d,d)O^{16}$, $O^{18}(d,\alpha)N^{14}$, $O^{18}(d,\alpha)N^{16}$, and $O^{18}(p,\alpha)N^{15}$ are presented. Alpha groups 70 kev apart were separated. (auth)

9080 IMPROVEMENTS IN ENCAPSULATED SILICON JUNCTION ALPHA DETECTORS. R. W. Jackson, P. P. Webb, and R. L. Williams (RCA Victor Co., Ltd., Montreal). IRE Trans. Nuclear Sci., NS-8: No. 1, 29-34(Jan. 1961).

Encapsulated silicon junction α detectors made with material of resistivity 1000 ohm-cm and with front layer depth of 2 μ are available in window areas of 5, 20, and 200 mm^2. Recent measurements on the best of these units gave resolutions of 0.6, 0.9, and 4% for 5.5-Mev α particles. For wider application, similar units were made with front layer depth of 0.2 μ and using material of resistivity up to 30,000 ohm-cm. Excitation of carriers by radiation of optical wavelengths showed that the effective dead layer is less than 0.03 μ. The necessity of making a solder contact and seal to the extremely thin front layer raised problems in the achievements of high stability, low leakage, and low noise at high voltages. Thus the depletion layer depths obtainable in encapsulated units with high resistivity material do not yet approach those obtainable in unencapsulated units in vacuum. A representative measurement obtained recently gave a resolution of 0.6% with a window area of 5 mm^2 (junction area 20 mm^2) and depletion layer depth of 180 μ. (auth)

9081 TRANSISTOR FORM OF NUCLEAR PARTICLE DETECTOR. R. L. Williams and P. P. Webb (RCA Victor Co., Ltd., Montreal). IRE Trans. Nuclear Sci., NS-8: No. 1, 35-42(Jan. 1961).

A transistor form of nuclear particle detector was fabricated using 20,000 ohm-cm p type silicon. With such high resistivity silicon and a wafer 10 mil thick, a bias voltage of 30 to 40 volts extends the depletion layer almost completely through the wafer, leaving a thin p-region so that the whole wafer becomes a transistor. A particle entering the device through the collector depletion layer produces ionization in this layer which is quickly swept out. The charge separation is such that the emitter is forward biased and a transistor pulse current flows subsequent to the collector diode current. The current time characteristics of the device are given and the gain of the device is considered both for light radiation and particle pulse signals. From a detailed consideration of the gain-bias characteristics, the lifetime in the base of the transistor was calculated. This was compared to the response time of the unit. The detector surface was found to have sensitivity variations by comparing the gain of the device obtained with a small light beam at several points on the surface. Variations in sensitivity are indicated by the shape of the resolution curves. Signal-to-noise ratios obtained are comparable to those realized with good amplifiers and similar area diodes. Typical gain figures are 200 to 300. The transistor impedance was found to be resistive having a value near 10 kilohms. Operation at CO_2 and liquid air temperature did not appear to give any gain in signal-to-noise ratio. The performance of the transistor device is discussed in terms of possible improvement and present limitations. (auth)

9082 N. I. P. SILICON JUNCTIONS DETECTORS. Lydie Koch, Jean Messier, and Jean Valin (Centre d'Études Nucléaires, Saclay, France). IRE Trans. Nuclear Sci., NS-8: No. 1, 43-9(Jan. 1961).

N.I.P. Silicon junctions were studied as particle detectors. They consist of a 1000 Ω cm silicon plate on each side of which, respectively, a p and n layer were diffused in order to have a NIP structure. The incident particles, 9 to 40-Mev α, were parallel with the junctions planes, and struck the detector in the I region. An energy resolution of 2% and a good linearity of pulse height vs. particle energy up to 40 Mev were obtained. In addition, γ rays were detected with NIP junctions, and pulse-height distribution of Co^{60}, Cs^{137}, and Hg^{203} was studied. The average amount of energy expended by a photoelectric electron in creating one electron-hole pair in silicon was measured and is found to

be: E = 3.53 ± 0.07 ev for 279 kev electrons and E = 3.55 ± 0.1 ev for 660 kev electrons. (auth)

9083 SEMICONDUCTOR ELECTRON DETECTORS. J. M. McKenzie and G. T. Ewan (Atomic Energy of Canada, Ltd., Chalk River, Ont.). IRE Trans. Nuclear Sci., NS-8: No. 1, 50-3(Jan. 1961).

The properties of p-n junctions made by phosphorus diffusion in 12,000 Ω cm p type silicon were examined using the Chalk River $\pi\sqrt{2}\,\beta$-ray spectrometer as a source of monoenergetic electrons. With 200 V reverse bias the depletion layer was thick enough to absorb totally 350-kev electrons. Up to 1200 kev some of the electrons were scattered sufficiently to deposit all their energy in the junction. This resulted in a total absorption peak up to electron energies of 1.2 Mev. However, at this energy most of the electrons acted like minimum ionizing particles and deposited 180 kev of energy in the junction. (auth)

9084 THE APPLICATION OF SILICON DETECTORS TO ALPHA PARTICLE SPECTROSCOPY. A. Chetham-Strode, J. R. Tarrant, and R. J. Silva (Oak Ridge National Lab., Tenn.). IRE Trans. Nuclear Sci., NS-8: No. 1, 59-63 (Jan. 1961).

The sensitivity for detection of low abundance groups in an α spectrum was found to be limited primarily by a low energy tail in the pulse-height distribution. The effects of scattering and source preparation on the magnitude of this tail were experimentally investigated. A theoretical lower limit of sensitivity for low abundance groups was calculated from consideration of scattering processes in the crystal. Background contamination in new detectors and the increase in background due to the collection of recoil nuclei were studied. Methods for minimizing the increase in background are suggested. A chamber, designed from a consideration of the above results, was constructed and used for the detection and measurement of low abundance groups in the α spectra of U^{234} and the actinium decay series. (auth)

9085 A GOLD-SILICON SURFACE-BARRIER PROTON RANGE TELESCOPE. R. Takaki, M. Perkins, and A. Tuzzolino (Univ. of Chicago). IRE Trans. Nuclear Sci., NS-8: No. 1, 64-72(Jan. 1961).

Of interest in cosmic-ray studies is the proton energy spectrum. The recent development of the Au-Si semiconductor particle detector affords a convenient means for studying the proton spectrum for low energies. The small size, stability, energy resolution, and relative insensitivity to β and γ radiation of these diodes suggest their usefulness as proton detectors on space vehicles. Gold-silicon detectors are presently being made at the Laboratories for Applied Sciences of the University of Chicago using the fabrication technique developed at the Oak Ridge National Laboratory. An apparatus is described which employs two detectors forming a proton range telescope. This was made possible by fabricating silicon wafers as thin as 0.004 in. This apparatus provides information concerning the proton flux lying in the energy intervals from ≈0.5 to 5 Mev and 5 to 10 Mev, without the use of push-height analysis. This principle can be extended to additional energy intervals. (auth)

9086 APPLICATION OF SOLID STATE DETECTORS TO HIGH ENERGY PHYSICS. G. L. Miller (Brookhaven National Lab., Upton, N. Y.), B. M. Foreman, Luke C. L. Yuan, P. F. Donovan, and W. M. Gibson. IRE Trans. Nuclear Sci., NS-8: No. 1, 73-8(Jan. 1961).

The application of solid-state detectors at high energies which depends on obtaining good signals from minimum ionizing events is discussed. Detectors for this application should be large in area, have reasonably thick depletion layers, and a low series resistance to ensure fast rise time. Low noise is not a prime requirement, however, since the Landau effect in any case limits the resolution to a low value. Using an analyzing magnet and counter telescope at the Brookhaven Cosmotron, diffused silicon junctions of up to 1.5 cm diameter were investigated using minimum ionizing particles. The signal-to-noise ratio obtained was ~10:1 and the resolution ~30%. (auth)

9087 SEMICONDUCTOR PARTICLE COUNTERS AT LOW TEMPERATURES. F. J. Walter, J. W. T. Dabbs, and L. D. Roberts (Oak Ridge National Lab., Tenn.). IRE Trans. Nuclear Sci., NS-8: No. 1, 79-82(Jan. 1961).

Studies of the behavior of semiconductor surface-barrier counters were made in the temperature range 0.2 to 300°K. A simple model which appears to describe the observed behavior is presented. Mountings suitable for low-temperature applications are described. (auth)

9088 NUCLEAR METHOD OF MEASUREMENT OF DIFFUSION LENGTH IN P-N JUNCTIONS. Lydie Koch (Centre d'Études Nucléaires, Saclay, France), J. Messier, and Quentin Kerns. IRE Trans. Nuclear Sci., NS-8: No. 1, 83-90(Jan. 1961).

A p-n germanium junction was irradiated with 4.8-, 6-, and 8.7-Mev α particles and 5-, 10-, and 11-Mev protons; the incident particles penetrated into the crystal perpendicularly to the junction plane. The depletion region was 0.7 μ wide and was located at a distance of 5.3 μ from the crystal surface. The variation of the charge collection efficiency vs. incident particle range in the material gave an accurate means of calculating the diffusion length of the minority carriers in the base material. (auth)

9089 FAST NEUTRON DAMAGE TO SILICON JUNCTION PARTICLE DETECTORS. R. V. Babcock (Westinghouse Electric Corp., East Pittsburgh). IRE Trans. Nuclear Sci., NS-8: No. 1, 98-102(Jan. 1961).

Two silicon junction charged-particle detectors were irradiated with fast neutrons distributed in energy from 0.5 to 6 Mev. Reverse current and pulse-height spectra of U^{234} α particles were observed at several bias voltages as functions of neutron dosage. The reverse current of both detectors increased roughly five fold during exposure to 1.2×10^{13} fast neutrons/cm^2. From the α pulse heights the capacitance (at some fixed bias) of one detector was found to increase roughly 25% per 10^{12} nvt. Approximately 50% of this change was restored by 1000 hr of annealing at room temperature. In the other detector, the α pulse height decreased at a similar rate, but the data were obscured by the development of unusually large pulse rise times. (auth)

9090 dE/dx AND E SEMICONDUCTOR DETECTOR SYSTEMS FOR 25-MEV He^3 AND ALPHA PARTICLES. H. E. Wegner (Los Alamos Scientific Lab., N. Mex.). IRE Trans. Nuclear Sci., NS-8: No. 1, 103-11(Jan. 1961).

Thin semiconductor detectors were constructed in which the space-charge region completely fills the volume of the detector. These detectors can be used to measure low-energy α particles in the usual way and can also be used for high-energy particles to measure dE/dx, the fractional energy lost in traversing a given amount of matter. A combination detector which measures both dE/dx and the total energy, E, of a particle is described, and performance with 21- and 25-Mev He^3 and α particles is shown. This combination allows various mass particles produced in a high-energy reaction to be completely separated. The manner of construction for these thin (0.002 in.) counters is described, and the advantages in terms of required size, signal-to-

noise ratio, and rise time are discussed. Energy resolution characteristics for NaI scintillation detectors and semiconductor detectors are compared for high-energy He^3 and α particles. (auth)

9091 THE EFFECT OF A HIGH RADIATION ENVIRONMENT OF GOLD–SILICON CHARGED PARTICLE DETECTORS. R. W. Klingensmith (Battelle Memorial Inst., Columbus, Ohio). IRE Trans. Nuclear Sci., NS-8: No. 1, 112-15(Jan. 1961).

A study was conducted to determine the effect of a high radiation environment on the response of gold–silicon surface-barrier detectors to Pu^{239} α particles. The controlling damage was due to fast neutrons although the detectors were exposed to a mixed γ-neutron field. After an exposure of 1000, the low-energy side of the response peak showed a definite but broad secondary peak. With increasing dose the original peak broadened but retained its pulse height and the secondary peak dropped in pulse height and became very broad. The total number of counts remained constant, being shared between the two peaks. After 5000 r exposure the original single-peak response was no longer evident. Thermal annealing at 180°C for several hours yielded only slight recovery. (auth)

9092 TEMPERATURE BEHAVIOR OF P-N JUNCTION DETECTORS. R. J. Grainger, J. W. Mayer, and J. W. Oliver (Hughes Aircraft Co., Culver City, Calif.). IRE Trans. Nuclear Sci., NS-8: No. 1, 116-23(Jan. 1961).

For practical considerations, improved resolution together with higher operating limits can be realized for shallow-diffused junction detectors operated in the temperature range from approximately 0 to –70°C. Detectors used above 50°C usually showed large amounts of deterioration of resolution. Detector noise generally governs the resolution that may be achieved. It appears that noise may arise from both surface and bulk currents, but the degree of contribution by each has yet to be determined. (auth)

9093 HOMOGENEOUS SOLID STATE IONIZATION DETECTOR. J. D. van Putten and J. C. Vander Velde (Univ. of Michigan, Ann Arbor). IRE Trans. Nuclear Sci., NS-8: No. 1, 124-8(Jan. 1961).

A gold-doped silicon crystal was used to measure the most probable energy loss and energy-loss distribution of π^- mesons at 1.50 Bev/c and 2.55 Bev/c. The crystal used was 2 cm in diameter and 0.25 cm thick. The preparation of the detector is discussed. The results confirmed the existence of a density effect in the relations describing the dependence of the most probable energy loss on particle momentum. The energy-loss distribution appeared to be broader than the predicted width. (auth)

9094 CONSIDERATIONS IN THE DESIGN OF PULSE AMPLIFIERS FOR USE WITH SOLID STATE RADIATION DETECTORS. Edward Fairstein (Tennelec Instrument Co., Oak Ridge, Tenn.). IRE Trans. Nuclear Sci., NS-8: No. 1, 129-39(Jan. 1961).

The definition of amplifier noise in terms of equivalent charge or equivalent electrons and the technique for its measurement in these terms is discussed in detail. Some of the theory which relates to the design of low-noise highly stable pulse amplifiers is reviewed. Tubes and other circuit elements suitable for use in low-noise amplifiers are discussed. The effect of the pulse shaping networks on the s/n ratio (shot noise and grid-current noise components) is described and data are given for the relative merits of single and double RC and delay line clippers in association with 1 to 5 RC integrators. It is shown, for example, that the noise performance of the double delay line clipper is noticeably inferior to that of the single RC clipper, although it is very much better with regard to permissible counting rate. (auth)

9095 LOW NOISE TRANSISTOR AMPLIFIERS FOR SOLID STATE DETECTORS. T. L. Emmer (Oak Ridge National Lab., Tenn.). IRE Trans. Nuclear Sci., NS-8, No. 1, 140-6(Jan. 1961).

The development of low-noise transistor amplifiers with solid-state detectors is discussed. A charge-sensitive integrating preamplifier employing a cascade circuit which results in an increased signal-to-noise ratio is shown. The voltage feedback amplifier, the high-input impedance preamplifier, and the current feedback amplifier are discussed and compared. (M.C.G.)

9096 AMPLIFIERS FOR USE WITH P-N JUNCTION RADIATION DETECTORS. R. L. Chase, W. A. Higinbotham, and G. L. Miller (Brookhaven National Lab., Upton, N. Y.). IRE Trans. Nuclear Sci., NS-8: No. 1, 147-50 (Jan. 1961).

The signal of radiation pulse detectors is in the form of a charge on a capacitor. An ionizing particle produces a charge pair for each 3.6 ev dissipated in silicon. The capacitance of a p-n junction is proportional to the area and inversely proportional to the square root of the bias potential. Three similar preamplifier circuits are described. Negative charge feedback was employed so that the output amplitude was essentially independent of the value of the detector capacitance. The amplifiers had a high open loop gain, a fast response, and show little tendency to oscillate. Best over-all performance, a noise line width of 5 kv, was achieved using WE417A or equivalent tubes in cascade at the input. RCA 7586 tubes gave a line width of 8 to 10 kv with low capacitance detectors. The line width with transistors was 20 to 30 kv. (auth)

9097 PULSE RISE TIME FOR CHARGED PARTICLES IN p-n JUNCTIONS. H. M. Mann, J. W. Haslett, and G. P. Lietz (Argonne National Lab., Ill.). IRE Trans. Nuclear Sci., NS-8: No. 1, 151-6(Jan. 1961).

The rise time of pulses from charged particles entering p-n junctions is of importance in the use of these devices for fast counting. For this application coincidence resolving times of the order of 10 nsec are presently useful. Measurements of rise time for α particles at 6 Mev were made using a system with limiting rise time 7.5 nsec. Surface barrier and diffused junction detectors showed a dependence of rise time t upon reverse bias V of the form $t \propto 1/V^x$ where $0.4 \leq x \leq 0.9$. The rise time was determined by the lifetime of minority carriers for some detectors, and for others, by the base resistivity. The results showed no limitation in application of these detectors to 10 nsec coincidence resolving times, since the depletion layer could be extended to reduce the effective RC time constant of the detector below 10 nsec. (auth)

9098 TRANSIENT RESPONSE OF P-N JUNCTION DETECTORS. C. T. Raymo and J. W. Mayer (Hughes Aircraft Co., Culver City, Calif.). IRE Trans. Nuclear Sci., NS-8, No. 1, 157-61(Jan. 1961).

The factors influencing the rise and decay of the transient voltage response of diffused silicon p-n junction detectors to individual nuclear particles are discussed. These factors include the charge collection time, the equivalent circuit of the detector, and the characteristics of the amplifier and display system. An equivalent circuit of the detector is presented. The effects of the series resistance of the detector and the variations in junction capacitance were studied. The decay time constants were measured as a function of load resistor. (M.C.G.)

9099 RADIOISOTOPE MEASURING INSTRUMENT FOR DETERMINATION OF DENSITY. J. Oppelt (Inst. für Forschung, Herstellung und Anwendung von Radioisotopen, Prague, Czechoslovakia). Isotopentechnik, 1: 23-4(Jan. 1960).

An instrument used to measure the density of the charge (cement slurry) is described. The instrument utilizes the absorption of radiation in a compensated circuit with two ionization chambers. The suitability of employing this type of instrument is discussed on the basis of practical experience. (auth)

9100 THE β-RAY COUNTING EFFICIENCY OF THE END-WINDOW COUNTER. Tatsusaburo Suzuki and Jiro Yuhara (Japan Defense Agency). J. At. Energy Soc. Japan, 2: 618-21(1960). (In English)

Variations in counting rate were measured as a collimated β-ray source was moved across the diameter of an end-window counter. The counting efficiency decreased when the β-ray beam collided with the central wire bead. As the distance of the source from the central axis increased, the counting efficiency decreased more rapidly in the halogen-quenched counter than in the organic-gas quenched counter. By measuring the counting rate at the threshold voltage of the counter, it can be determined if the end-window mica has uniform thickness. (auth)

9101 USING THE DECAY OF Ba^{137} TO DETERMINE RESOLVING TIME IN G-M COUNTING. Robert L. Stearns and Joseph F. Mucci (Vassar Coll., Poughkeepsie, N. Y.). J. Chem. Educ., 38: 29-30 (Jan. 1961).

A laboratory method is given for determining the resolving time of a G-M counting system. The method consists of separating the 2.6-min Ba^{137} daughter from Cs^{137} on $BaCO_3$, following the Ba^{137} decay with a counter over ~10 half lives, and making a semilog plot of counting rate vs. time. For sufficiently large counting rates, the curve will not entirely be a straight line, and by extrapolating the straight line portion of the curve, the resolving time loss of the counting system can be read directly from the plot as $n - m = nm\tau$, where m is the measured counting rate, n is the rate for zero resolving time, and τ is the resolving time. Experiments were performed according to this method on a G-M tube and scalers of resolving times 5 and 150 μsec. (D.L.C.)

9102 MEASUREMENT OF THE HALF LIFE OF $UX_2(Pa^{234})$ WITH A DIPPING COUNTER. Jerry Braunstein and Raymond H. Young (Univ., of Maine, Orono). J. Chem. Educ., 38: 31-2 (Jan. 1961).

A simple laboratory method for measuring the half life of Pa^{234} is described. The method consists of the following steps: An ion exchange column is prepared from a slurry of Amberlite IR-120 in water and connected to a counting chamber via a capillary tubing and a stopcock. A solution of uranyl nitrate is passed through the column, followed by a H_2SO_4 rinse which elutes the uranium and a HCl rinse which elutes Pa^{234}, leaving its parent Th^{234} behind; the HCl eluant is then passed into the counting chamber to be counted. The half life is calculated from the counting data and was found to be 1.21 ± 0.03 min for a dipping Geiger tube and two different scalers, in excellent agreement with the accepted value of 1.18 min. (D.L.C.)

9103 EFFECT OF SOLVENT AND SOLUTE STRUCTURE ON SCINTILLATOR PULSE HEIGHTS. I. CORRELATION OF PULSE HEIGHTS FOR RING SUBSTITUTED STYRENE PLASTIC SCINTILLATORS WITH HAMMETT SUBSTITUENT CONSTANTS. Stanley R. Sandler and Samuel Loshaek (Borden Chemical Co., Philadelphia). J. Chem. Phys., 34: 439-44(Feb. 1961).

A group of different ring substituted styrene plastic scintillators was prepared with a constant concentration of p-terphenyl as the fluor and POPOP as the waveshifter. The effect of this variation in the structure of the polymer phase on pulse-height response to β and γ radiation was determined. It was found that correlations exist between the relative pulse height and the Hammett (σ) and Taft (σ_I) substituent constants for the substituted polystyrenes. Pulse heights increase with an increase in the negative value of the substituent constant, i.e., with an increase in the electron-donating power of the ring substituent on the polystyrene. It was found that markedly lower relative pulse heights were obtained for a series of styrene plastics in which the α-hydrogen in the backbone chain was substituted by a methyl group. This suggests that an α-hydrogen in the backbone chain is required for an efficient plastic solvent. (auth)

9104 EFFECT OF SOLVENT AND SOLUTE STRUCTURE ON SCINTILLATOR PULSE HEIGHTS. II. CORRELATION OF PULSE HEIGHTS FOR AROMATIC LIQUID ORGANIC SCINTILLATORS WITH HAMMETT SUBSTITUENT CONSTANTS. Stanley R. Sandler and Samuel Loshaek (Borden Chemical Co., Philadelphia). J. Chem. Phys., 34: 445-7(Feb. 1961).

It has been found that numerous data in the literature on aromatic organic liquid scintillators could be interpreted in terms of the resonance and polarity of the constituent solvents and fluors. The resonance and polarity of the ring substituted aromatic compounds were characterized quantitatively by Hammett substituent constants (σ). For a number of liquid scintillator systems in which the fluor composition was kept constant and the structure of the aromatic solvent was varied, pulse heights increased approximately linearly with increasing electron donating (negative σ values) power of the substituents on the aromatic molecule. This correlation held for nine different fluors in each of seven different aromatic solvents. A similar correlation was found for a series of fluors consisting of substituted 2,5-diphenyl-1,3,4-oxadiazoles and 2,5-diphenyl 1,3-oxazoles in which toluene was used as the sole solvent. Pulse heights varied much more with a change in substituent groups on the solvent than with a similar change in the fluors. The observed correlation affords a means of organizing a large body of data and of gaining a further insight into the mechanism of scintillation. (auth)

9105 LUMINESCENCE IN A SCINTILLATION SOLUTION EXCITED BY α AND β PARTICLES AND RELATED STUDIES IN QUENCHING. Isadore B. Berlman (Argonne National Lab., Ill.). J. Chem. Phys., 34: 598-603(Feb. 1961).

The relative intensity of the light pulses produced by α and β particles in a scintillating solution of 2,5-diphenyloxazole in xylene was investigated as a function of the concentration of the solute. The α/β ratio was substantially smaller than that found in organic plastic scintillators. From the data the dynamic quenching parameter was calculated. Several independent experiments, i.e., measurements pertaining to mean lifetime of fluorescence, uv excitation, and pulse heights, were undertaken to study the mechanisms of quenching by oxygen in a scintillating solution. The best interpretation of the oxygen effect is consistent with the existence of dynamic quenching of the solvent and of the solute. (auth)

9106 INFORMATION CAPACITY OF RADIATION DETECTORS. R. Clark Jones (Polaroid Corp., Cambridge, Mass.). J. Opt. Soc. Am., 50: 1166-70 (Dec. 1960).

The information capacity of a radiation detector is de-

noted by C and is measured in bits per second. The root-mean-square radiation power incident on the detector is denoted by P and is measured in watts. Interest is focused on the ratio C/P = I, measured in bits per joule. When I is referred to unit detector area, it is denoted by I* and is measured in bits per (joule/cm). It is shown that for most detectors, the information capacity I has a maximum value for a finite and determinable value of the power P, and that the maximum corresponds to an electrical signal-to-noise ratio in the output of the detector that is of the order of magnitude of unity. It is further shown, subject to a suitable simplifying approximation, that the information capacity I* is equal to one-half of the energy detectivity Δm^* of the detector, and that if the modulation of the radiation power is confined to a 1-cps band centered at the frequency f, the information capacity I* is equal to the detectivity $D^*(f)$ of the detector. The analysis of the information capacity is divided into two parts. One uses a simplifying approximation and includes numerical results for a number of kinds of detectors, including the dark-adapted human eye, Royal-X photographic film, multiplier phototubes, and cooled infrared detectors. The other contains an exact analysis for two important cases. (auth)

9107 MASS DEPENDENT ION COLLECTION EFFICIENCIES IN A MASS SPECTROMETER. Don A. Kubose and William H. Hamill (Univ. of Notre Dame, Ind.). J. Phys. Chem., 65: 183-4(Jan. 1961).

For calculation of gaseous ion-molecule reaction cross sections from mass spectrometer data, the collection efficiencies for the primary and secondary ions must be known. A method for determining the discrimination among ions of different m/e is given in which the ratio of the analyzed ion current to the total saturation current is compared for various m/e values. Data were collected for H_2, D_2, CH_4, CD_4, Ne, C_2H_2, H_2S, Ar, Kr, and Xe gases and normalized to unity for xenon. There is little discrimination for any repeller field except for a small increase at low m/e. (D.L.C.)

9108 AUTOMATIC CORRECTION OF COUNTING LOSSES IN A GEIGER-MÜLLER COUNTER USED WITH PERIODICALLY VARYING RADIATION. B. B. Trott (University Coll., Cardiff, Wales). J. Sci. Instr., 38: 20-1 (Jan. 1961),

Correction is achieved by reducing the number of uniformly-spaced timing pulses recorded during the reception of a particular number of pulses from the counter. The action and performance of a circuit which restricts to a suitable portion of the radiation cycle the registration of timing pulses are described. (auth)

9109 NEUTRON FLUX MEASUREMENTS AT THE FRM WITH A THERMOCOUPLE. W. Schilling (Technische Hochschule, Munich, Germany). Kerntechnik, 2: 398-400 (Dec. 1960). (In German)

The construction and operation of an apparatus, which uses the heat generation in the irradiation of a small mass of uranium with thermal neutrons for the measurement of the neutron flux, are described. The reading is a linear function of the neutron flux. The calibration was done first in a neutron flux measured with gold foils and then with the flux distribution measured in the core of the FRM with a thermopile and with the calorically determined reactor power. (tr-auth)

9110 METHOD FOR THE DETECTION OF LEAKS IN THE CLADDINGS OF FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Licentia Patent-Verwaltungs-GmbH., Hamburg). German Patent 1063292. Kerntechnik, 2: 404 (Dec. 1960). (In German)

A device for the detection of leaks in reactor fuel claddings is described. The instrument is based on the detection of xenon in the coolant gas or the protective atmosphere of the reactor. The detection is done spectrometrically or radiometrically in a Clusius tube. (J.S.R.)

9111 MAGNETIC AMPLIFIER IN REACTOR INSTRUMENTATION. P. Schranz and A. Stebler. Kerntechnik, 2: 408-10(Dec. 1960). (In German)

The utilization of magnetic amplifiers for monitoring the reliability of reactor instrumentation is discussed. Examples of such applications are given. (J.S.R.)

9112 A SILICON γ-RAY SPECTROMETER. P. E. Gibbons and D. C. Northrop (Services Electronics Research Laboratory, Baldock, Herts, England). Nature, 188: 803 (Dec. 3, 1960).

An investigation was made of current pulses produced by the passage of ionizing particles through high-resistivity silicon. Ohmic contacts were made to the specimen by alloying into a boron-diffused surface layer with Ga–Au wire. Cobalt-60 γ rays produced pulses to a maximum of 2 mv, for which the signal-to-noise ratio is greater than 50 at liquid air temperatures, offering the possibility of high-resolution spectroscopy. At room temperatures γ energies of 1 Mev and α energies of 4 Mev were detected, with signal-to-noise ratios suitable for monitoring purposes. (B.O.G.)

9113 INVESTIGATION OF ELEMENTARY PARTICLES WITH THE HELP OF NUCLEAR EMULSIONS. A. G. Tenner (Universiteit, Amsterdam). Ned. Tijdschr. Natuurk., 26: 109-17(Apr. 1960). (In Dutch)

The utilization of nuclear emulsions in the study of elementary particles is illustrated with some examples. The instrumentation used for the initial scanning and final measurement of the tracks in the emulsion stacks is described. The disintegrations found from irradiation of the emulsions with π^- at 5.5 Bev are discussed. The decay of K^+ in nuclear emulsions is then illustrated. The differential cross section for K^+ scattering in nuclear emulsions is given. An apparatus for the measurement of small-angle scattering in emulsions is then described. (J.S.R.)

9114 REVERSIBLE GAIN VARIATIONS OF PHOTOMULTIPLIERS BY CHANGE IN COUNT RATE. H. Jung, Ph. Panussi, and J. Jänecke (Max-Planck-Institut für Kernphysik, Heidelberg, Ger.). Nuclear Instr. & Methods, 9: 121-30(Nov. 1960). (In German)

The time dependence of the gain of several RCA, DuMont, and EMI photomultiplier tubes was measured prior to, during, and after a constant illumination of the photocathode. The light source was a NaI(Tl) crystal irradiated with γ rays of Cs^{137} or Co^{60}. A change in the counting rate resulted in rapid and slow variations in the gain. The rapid gain variations took place within an interval of less than 10 sec. The amplitude was dependent upon the change in counting rate and the tube chosen. The sign could be positive or negative for individual tubes of the same type. It was assumed that a sudden reversible sensitization or desensitization of the photocathode explains the effect. The slow gain variations after a change in counting rate were made up of two exponential components. The respective saturation value after an increase in counting rate was approached faster than after a decrease in counting rate. The amplitude was dependent upon the average anode current and the high voltage. It was assumed that reversible dynode effects explain the changes in gain variations. The different behavior of the various types of photomultiplier tubes is not correlated to the dynode material. The absolute value of the gain variations of all tubes examined were

approximately of the same magnitude under comparable conditions. (auth)

9115 HIGHER ORDER CHANCE COINCIDENCES IN A FAST-SLOW COINCIDENCE ARRANGEMENT. Helmut Paul (Purdue Univ., Lafayette, Ind.). Nuclear Instr. & Methods, 9: 131-6(Nov. 1960). (In English)

An ordinary fast-slow coincidence measurement with two radiation detectors is considered. In addition to the chance coincidences due to two pulses (one from each detector) there are higher-order chance coincidences which require a total of three or four pulses and whose relative contributions to the counting rate increase with source strength. Formulas for these effects are given, and methods for measuring the corrections are discussed. For a source with a simple decay scheme and for the special cases of either very narrow or very wide analyzer channels it is shown that the higher-order corrections may be neglected if the single counting rates are small compared to the reciprocal resolving time of the slow coincidence circuit. (auth)

9116 A NOTE ON THE BACKGROUND IN NaI SCINTILLATION COUNTERS. S. Raboy and C. C. Traul (Argonne National Lab., Ill.). Nuclear Instr. & Methods, 9: 145-8(Nov. 1960). (In English)

The residual background in sodium iodide (thallium-activated) crystals was studied with the scintillation spectrometer with an anticoincidence annulus. The characteristic response of this system to γ rays was used to identify background peaks as coming from γ rays and not-charged particles. There were contributions from the natural radioactivity of K^{40}, the Th^{232} series, and the U^{238} series. By controlled experiments it was concluded that the decays from K^{40} and the U^{238} series originate in the room surroundings and that the activity from the Th^{232} series originates in the immediate vicinity of the sodium iodide crystal, such as the materials of the package. The results were consistent with the assumption of no radioactive contaminant within the crystal itself. (auth)

9117 METHOD OF EVALUATING DELAYED COINCIDENCE EXPERIMENTS. R. S. Weaver and R. E. Bell (McGill Univ., Montreal). Nuclear Instr. & Methods, 9: 149-53(Nov. 1960). (In English)

Frequently in delayed coincidence work a resolution curve is measured with good accuracy, but no exactly comparable prompt resolution curve is available. The centroid-shift method of evaluating the lifetime τ cannot be applied because the zero of time (centroid of the prompt curve) is not known. If τ is close to the instrumental limit, it cannot be measured from the logarithmic slope of the measured resolution curve. An objective measure of the asymmetry of the measured curve is then required, calculable without reference to any other curve. Such a quantity is the third moment of the measured curve about its own centroid. It is shown that the normalized third moment is equal to $(2\tau^3 + \epsilon)$, where ϵ is the normalized third moment of the prompt curve, usually small and frequently negligible. Thus τ can be evaluated with at most only rough knowledge of the prompt curve. The McGill IBM 650 computer was programmed to perform the arithmetical work, which is otherwise laborious. An application to an actual example is shown. Estimates are given of the accuracy to be expected from the method. (auth)

9118 SECTOR-TYPE DOUBLE-FOCUSING BETA-RAY SPECTROMETER. M. Sakai, H. Ikegami, and T. Yamazki (Tokyo Univ.). Nuclear Instr. & Methods, 9: 154-64(Nov. 1960). (In English)

A new type of magnetic β spectrometer especially suitable for electron-γ and electron-electron directional correlation experiment was constructed. It is a version of an ordinary sector type double-focusing spectrometer which accepts a large solid angle. Since the spectrometer was so designed that the wall of the vacuum chamber serves as the return circuit of magnetic flux, a scintillation counter or another spectrometer can be put in the space entirely free from magnetic field. Several examples for conversion spectrum, electron-γ coincidence spectrum, and pattern of electron-γ directional correlation are presented. (auth)

9119 ON THE MECHANISM OF MULTIPLE DISCHARGES IN HALOGEN-QUENCHED G.M. COUNTERS. O. J. Orient (Central Food Research Inst., Budapest). Nuclear Instr. & Methods, 9: 165-71(Nov. 1960). (In English)

Multiple discharges taking place during the excitation section in counting tubes filled with neon gas to 200 and bromine to 0.5 mm Hg pressure were investigated. The amplitude and distribution in time of multiple discharges were examined with an oscillo-synchroscope. Multiple discharges occurred after dead time. Their amplitudes were always smaller than the main pulse. Their number diminished and their amplitude increased with time. In the excitation section multiple discharges were separated with a threshold discriminator. Performances examined with this method show no excitation section. This confirmed the observation that excitation section is due to multiple discharges of amplitudes smaller than the main discharge. For the distribution in time of multiple discharges the evaluation of the measurements resulted in an exponential relationship. The value obtained for the constant term making part of the exponent was found to be identical with the decay constant of metastable neon atoms. This confirmed the assumption that multiple discharges are originated by ultraviolet photons resulting from the decay of metastable neon atoms produced around the filament in the main discharge. By using the exponential time distribution of multiple discharges as obtained in measurements, the probability of multiple discharges originating from metastable disintegration was calculated. (auth)

9120 SMALL SCATTERING CHAMBER FOR LARGE ANGULAR REGION. H. R. E. Tjin A Djie, F. J. de Heer, and L. A. Ch. Koerts (Instituut voor Kernphysich Onderzoek, Amsterdam). Nuclear Instr. & Methods, 9: 172-4(Nov. 1960). (In English)

A description is given of a small vacuum chamber for scattering of charged particles on nuclei at low and intermediate energies (< 30 Mev). The chamber has an angular range of 0 to 160° and can be used without foils in front of the counters. (auth)

9121 A METHOD FOR THE MEASUREMENT OF GAMMA-RAY SPECTRA IN OMNIDIRECTIONAL GAMMA-RAY FIELDS. L. C. Thompson (Univ. of Georgia, Athens). Nuclear Instr. & Methods, 9: 175-80(Nov. 1960). (In English)

A method is presented for analyzing pulse-height distributions from a scintillation detector exposed to an omnidirectional γ-ray field through a collimator opening in a lead shield. The method is a combination of analytical and experimental procedures and provides corrections for collimator penetration and scattering effects. (auth)

9122 THE RAPID RECOGNITION OF A SIGNIFICANT INCREASE IN THE RATE OF ARRIVAL OF PULSES OCCURRING AT RANDOM. C. H. Vincent (Atomic Weap-

ons Research Establishment, Aldermaston, Berks, Eng.). Nuclear Instr. & Methods, 9: 181-94(Nov. 1960). (In English)

There is a fundamental lower limit to the time in which it is possible to recognize an excursion in the mean rate of pulses occurring at random and to distinguish it reliably from a chance fluctuation. This lower limit was found and evaluated numerically for the case of an exponential excursion. It is possible to build relatively simple electronic equipment which will give indication of such an excursion in little more than the absolute minimum time over a wide range of conditions of initial pulse rate and of excursion period. An example of such a circuit is described and shown to be capable of responding in less than one period of the excursion or in less than the time to count 200 pulses at the initial rate, whichever is the greater. This circuit will give false indication only on extremely rare voltage fluctuations exceeding 10 standard deviations, which are of negligible probability per year. It is suggested that the method described may be of use to give rapid warning of excursions in reactors and critical assemblies. In any case, the theoretical optimum found constitutes a standard of reference by which equipment for such warning may be judged. (auth)

9123 ON RESOLUTION AND LUMINOSITY OF A NEUTRON DIFFRACTION SPECTROMETER FOR SINGLE CRYSTAL ANALYSIS. G. Caglioti, A. Paoletti, and F. P. Ricci (Comitato Nazionale per le Ricerche Nucleari, Rome). Nuclear Instr. & Methods, 9: 195-8(Nov. 1960). (In English)

Some criteria for the choice of the collimators for a crystal spectrometer for neutron diffraction were established in order to achieve a good compromise between luminosity and resolution. General expressions for the full width at half maximum and for the luminosity of the diffraction peaks were developed for single crystal samples. (auth)

9124 A HIGH TEMPERATURE SPUTTERING ION SOURCE FOR A LABORATORY ISOTOPE SEPARATOR. W. L. Rautenbach (National Physical Research Lab., Pretoria). Nuclear Instr. & Methods, 9: 199-211(Nov. 1960). (In English)

The general principles governing the operation of a high-temperature sputtering ion source are discussed, and a technical description of the ion source is given. Special attention was given to discharge characteristics, ion currents in the sputtered metals, realization of selfsputtering, efficiency in sputtered material, and the average time spent by sputtered atoms on the walls of the discharge chamber. Possible uses for this type of ion source are discussed briefly. (auth)

9125 A PRECISION CLOCK FOR MEASURING TIME INTERVALS. R. W. Findley, R. A. Reiter, and T. A. Romanowski (Carnegie Inst. of Tech., Pittsburgh). Nuclear Instr. & Methods, 9: 221-5(Nov. 1960). (In English)

A precision electronic clock that uses 10-Mc pulses to measure time intervals is described. The linearity and the average channel width of the system were determined by measuring time intervals between randomly distributed pulses. In these tests about 250,000 counts per channel were accumulated showing that the system was linear. The slope of the random distribution of pulses was 0.00002 ± 0.0003 per channel. It was also found, to an accuracy of 0.016%, that the channel width of the time scale was equal to the period of the 10-Mc oscillator. This system is suitable for time interval measurements in a region from 0 to 15 μsec with an 0.1 μsec resolution. (auth)

9126 PULSE SHAPE DISCRIMINATION AND ENERGY RESPONSE OF CALCIUM TUNGSTATE CRYSTALS. W. R. Dixon and J. H. Aitken (National Research Council, Ottawa). Nuclear Instr. & Methods, 9: 229-32(Nov. 1960). (In English)

The scintillation response of calcium tungstate crystals to γ rays, protons, and α particles was studied. It is shown that there is a difference in shape between γ-ray and α-particle pulses, and that this effect may be exploited to discriminate between particles. (auth)

9127 MAGNETIC FIELD STABILIZATION IN NUCLEAR MAGNETIC RESONANCE MASER. P. Grivet and H. Hahn (Université, Paris). Nuclear Instr. & Methods, 9: 233-41(Nov. 1960). (In French)

A system is described for regulating the magnetic field of an electromagnet with an accuracy significantly superior to the limit accessible with a current regulator. The essential element is a nuclear resonance maser using a liquid stream for linking the magnetic field with the frequency of a radio signal generated by the maser. The structure and relevant properties of this peculiar form of maser are described. The theory is compared with the measured values obtained with the equipment. (auth)

9128 A ONE-METER-RADIUS IRON-FREE DOUBLE-FOCUSING $\pi\sqrt{2}$ SPECTROMETER FOR β-RAY SPECTROSCOPY WITH A PRECISION OF $1:10^5$. R. L. Graham, G. T. Ewan, and J. S. Geiger (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nuclear Inst. & Methods, 9: 245-86(Dec. 1960). (In English)

A high resolving power, high luminosity $\pi\sqrt{2}$ spectrometer employing a novel coil geometry which leaves ample room for large, accessible source and detector assemblies is described. The exact coil diameters and spacings used to achieve axial focusing up to the fourth order were specified by Lee-Whiting after a detailed theoretical study of the electron optical focusing properties of the coil arrangement. Four pairs of precisely manufactured coils generate the cylindrically symmetrical field whose shape closely approximates a $1/\sqrt{r}$ form near the optic circle, $r_0 = 100$ cm. The largest pair has 560 turns per coil and a mean diameter of 395.1 cm. The temperature control arrangements for this all-aluminum spectrometer ensure a constancy in the calibration ratio, gauss centimeter per ampere, of better than 1 part in 10^5 for electron energies up to 4 Mev. At resolution settings of 0.01%, 0.1%, and 1.0%, transmission values of 0.08%, 0.26%, and 1.1%, respectively, can be used. At resolution settings of 0.1%, or better, the luminosity (source area times transmission) is larger than the luminosities of other precision spectrometers. The degaussing system, iron-free building, source, baffle and detector arrangements, current-regulating and measuring systems, automatic controls, and readout system are discussed briefly. Several examples of the performance at resolution settings in the range 0.1 to 0.01% are given which illustrate this instrument's luminosity, ultimate resolution in momentum of 1 part in 10^4, and inherent precision of 1 part in 10^5. (auth)

9129 BEHAVIOUR OF PHOTOMULTIPLIERS AGAINST SHORT LIGHT-PULSES. C. Cernigoi, I. Gabrielli, and G. Iernetti (Università, Trieste and Istituto Nazionale di Fisica Nucleare, Trieste). Nuclear Instr. & Methods, 9: 303-14(Dec. 1960). (In English)

The response of some photomultipliers to very short light-pulses was investigated. Three light sources were used: hydrogen discharge, plastic scintillator, and Cherenkov light. The hydrogen discharge lamp was used for tests where a fixed time reference was required. Comparison of the responses to the three kinds of light pulses and

the single electron pulses gave some characteristic features of the photomultipliers. (auth)

9130 THE OPTICAL PROPERTIES OF SLOW CHOPPER AND TIME-OF-FLIGHT DEVICE. E. Maliszewski (Inst. of Nuclear Research, Academy of Sciences, Warsaw). Nuclear Instr. & Methods, 9: 341-6(Dec. 1960). (In English)

The transmission and resolution of a slow chopper and time-of-flight device were determined experimentally and compared with theoretical curves. The shape of the neutron pulse was also measured. (auth)

9131 ON THE DESIGN OF QUADRUPOLE FOCUSING SYSTEMS. W. Weidemann (National Physical Research Lab., Pretoria). Nuclear Instr. & Methods, 9: 347-53(Dec. 1960). (In English)

The theory necessary for the design of a quadrupole focusing system is set out, followed by a practical design example and the conclusions that can be drawn from the results. (auth)

9132 A RAPID CYCLING BUBBLE CHAMBER. L. Bertanza, P. Franzini, I. Mannelli, and G. V. Silvestrini (Università, Pisa, Italy and Istituto Nazionale di Fisica Nucleare, Pisa, Italy). Nuclear Instr. & Methods, 9: 354-6 (Dec. 1960). (In English)

The design and operation of a 1.12 liter propane-ethane gas bubble chamber, operated at room temperature with a repetition rate of 4 to 5 expansions per second, are described. The chamber worked in good stability condition for several periods of 20 to 40 hr each. (auth)

9133 A-C IONIZATION CHAMBERS ARE SIMPLE AND RELIABLE. David L. Roberts (United Kingdom Atomic Energy Establishment, Winfrith, Heath, Eng.). Nucleonics, 19: No. 2, 53-7(Feb. 1961).

Experiments with a-c operation of ionization chambers are described, and the applications of the improved method are discussed. The standard British RC/1 with boron-coated electrodes was used in the studies. Two modes of operation are possible: low-voltage, in which there is linear response for small collecting potentials, and high-voltage in which saturated collection and increased ranges of operation is achieved. The current waveform depends on frequency and amplitude of the applied potential and on the nature of the filling gas. An a-c operated chamber has the advantages of low drift and relative simplicity. Application in simplifying the instrumentation of a reactor shutdown channel is described. (T.R.H.)

9134 GAS IONISATION NEUTRON DETECTORS. Wacław Dąbek, Adam Kazimierski, and Jerzy Topa (Inst. of Nuclear Research, Warsaw). Nukleonika, 5: 597-609 (1960). (In English)

Gas ionization neutron detectors are described which were developed in the Institute of Nuclear Research for reactor control (d-c, pulse fission, and BF_3 proportional detectors) and for neutron flux distribution measurement (miniature pulse fission and miniature BF_3 proportional detectors). (D.L.C.)

9135 SPECTROMETER FOR THE DETERMINATION OF POSITRON AND GAMMA-RAY CASCADE-EMITTING NUCLIDES. K. Ljunggren (Royal Inst. of Tech., Stockholm). Pure and Appl. Chem., 1: No. 1, 31-4(1960). (In English)

A three-channel coincidence spectrometer for determination of nuclides which emit positrons or gamma cascades is described. Several examples of its use in activation analysis are given. (tr-auth)

9136 DETECTION OF LOW ENERGY β^- RAYS. PART I. R. Schayes. Rev. M.B.L.E., 3: 95-123(Apr. 1960). (In French)

General features of β^- sources are presented with special emphasis on self-absorption effects in thick sources. Various types of detectors suitable for measuring low energy β^- rays are reviewed. Some methods of discriminating signal noise from background noise are described. Two photomultipliers operating on the coincidence principle permit considerable reduction of the background noise. A system is described which was designed for scintillation measurements of β^- rays emitted by a continuously flowing liquid. (auth)

9137 THE "SPECTROVIDE," A NEW VACUUM EMISSION SPECTROMETER. M. de Belder and M. Lambion. Rev. M.B.L.E., 3: 125-44(Apr. 1960). (In French)

The "Spectrovide" is a direct reading spectrometer which gives a quick, reliable, and economic solution to the problem of phosphorus, sulfur, and carbon in steel and pig iron. Analytical spectrum lines of these elements are located in the far ultraviolet. Since air is a highly absorbing medium for such radiations, the optical path must be in a vacuum. The operation and analytical conditions are described. Some results of analyses made on steel samples of various origin are reported. The comparison of these results with the results from chemical analyses shows the accuracy of the instrument. (auth)

9138 IMPROVED METHODS FOR DEVELOPMENT OF THICK-LAYER EMULSIONS (400μ). M. Nikolae. Rev. phys., Acad. rép. populaire Roumaine, 5: 229-38(1960). (In Russian)

The effects of soaking time in cold development, pH of the developer, temperature of the hot stages, and KBr admixtures on the developed layer were studied for thick-layer, 400μ emulsion. The best results from the developing point of view (uniform depth exposure, better grain density at minimum ionization, and reduced surface fog) were obtained with 3 to 5°C soaking for 2.5 hr in developer of 4 g amidol, 20 g sodium sulfite, 0.8 g potassium bromide, 2 g citric acid, and up to 1 liter of water; with 3 to 5°C soaking for 0.5 hr in the above developer dissolved with admixtures of 0.6 g KBr per liter and a hot stage of 45 min as 24°C. In comparison to the ordinary method, the suggested method improves the depth by 6 to 10%, increases the grain density at minimum ionization by 12 to 15%, and reduces surface fog 20%. (R.V.J.)

9139 ARRANGEMENT FOR ELECTROCHEMICAL POTENTIAL-TIME MEASUREMENTS IN THE MILLIMICROSECOND RANGE. E. Blomgren, D. Inman, and J. O'M. Bockris (Univ. of Pennsylvania, Philadelphia). Rev. Sci. Instr., 32: 11-12(Jan. 1961).

An arrangement is described which allows potential-time measurements in galvanostatic pulse techniques to be performed 40 to 80 mμsec after initiation of the pulse. (auth)

9140 THERMOCOUPLES FOR USE IN CARBON ATMOSPHERES. M. R. Nadler and Charles P. Kempter (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instr., 32: 43-7(Jan. 1961).

Criteria are discussed for using thermocouples in carbon atmospheres above 2000°C. Experimental data are given for W/Re, W/W-25 Re, Re/W-25 Re, graphite/Re, and graphite/Ir thermocouples in carbon atmospheres from room temperature to 2200°C. Reaction temperatures of carbon with thoria, urania, and yttria were measured to be below 1730, 1620, and 1590°C, respectively. (auth)

9141 VARIABLE SENSITIVITY AUTOMATIC IONIZATION CHAMBER. H. V. Neher (California Inst. of Tech., Pasadena). Rev. Sci. Instr., 32: 48-9(Jan. 1961).

An all quartz electroscope system is described which has a sensitivity that may be varied over a wide range by changing one potential. Like other previously described systems, it accumulates a definite quantity of electric charge, for given potentials, and then automatically recharges itself. When this recharging occurs an electrical pulse may be taken off for recording purposes. It is possible to change the sensitivity by a factor of 500. (auth)

9142 A 30-KILOWATT, 500-MICROSECOND VACUUM TUBE PULSER. Robert A. Kawcyn (Univ. of Illinois, Urbana). Rev. Sci. Instr., 32: 56-7(Jan. 1961).

A vacuum tube pulser which was developed for the operation of gas discharge tubes used in plasma research is described. It is capable of supplying a load with rectangular current pulses of as much as 12 to 15 amp for durations from 30 to 500 μsec with a voltage drop across the load up to 3500 volts. The maximum duty cycle at high currents is 0.005. (auth)

9143 ARC SOURCE FOR HIGH TEMPERATURE GAS STUDIES. John B. Schumaker, Jr. (National Bureau of Standards, Washington, D. C.). Rev. Sci. Instr., 32: 65-7 (Jan. 1961).

A wall-stabilized water-cooled copper ring type arc source is described which operates stably in apparently any gas for periods of an hour or more at currents up to 100 amp. Arc temperatures obtained spectroscopically by absolute line intensity and line profile methods are given for the arc in nitrogen at 92 amp. (auth)

9144 SIMULATOR FOR HIGH DENSITY ION GUNS. Raymond Fox (Univ. of California, Livermore). Rev. Sci. Instr., 32: 77-82(Jan. 1961). (UCRL-5685)

A simulator for an ion gun is used to predict the ion trajectories in the gun for a given electrode geometry. One simulator control is used for the space charge simulation of the entire ion beam. The beam is divided into cells of different areas in such a manner that each cell has the same space charge. Potential measurements are made at the boundaries of the cells where the accuracy of the space charge simulation is the greatest. A trajectory plotter is described which consists of a miniature tricycle, a voltage balancing unit (the same unit used in d-c millivolt recorders), a d-c regulated power supply, and a number of resistors. The trajectories are found by "steering" the tricycle across the simulator. The trajectory plotter and the method of space charge simulation were checked experimentally and were found to have good accuracy. (auth)

9145 USE OF AN ION PUMP AS A LEAK DETECTOR. J. R. Young (General Electric Research Lab., Schenectady, N. Y.). Rev. Sci. Instr., 32: 85(Jan. 1961).

A cold cathode gas discharge ion pump was used as a leak detector and found to operate satisfactorily. Argon, helium, oxygen, and hydrogen were used effectively as probe gases with argon usually giving the greatest response. Leaks from 10^{-3} to 10^{-5} std cc/sec could be located in a few minutes and leaks as small as 10^{-10} std cc/sec or 10^{-7} μliter/sec could be detected. (auth)

9146 PRECISE COLLIMATION AND ALIGNMENT MECHANISM FOR THE SPINCO MODEL E ULTRACENTRIFUGE. R. J. Bolen, E. A. Pavelka, J. R. Lindley, and C. W. Dwiggins, Jr. (Bureau of Mines, Bartlesville, Okla.). Rev. Sci. Instr., 32: 94-5(Jan. 1961).

A simple effective collimation and alignment mechanism for Schlieren optics in the Spinco model E ultracentrifuge is described. It consists of a pair of jaws sliding in a dovetailed block, one jaw having the slit and being movable by a micrometer screw. A feeler gage between the jaws sets the desired slit opening. A bull's-eye level is attached. (T.R.H.)

9147 MEASUREMENTS OF NEUTRON ENERGY BY GAS-RECOIL COUNTER. Hisanobu Kobayashi. Sci. Papers Inst. Phys. Chem. Research (Tokyo) 54, 255-60 (Sept. 1960). (In English)

The gas-recoil counter is a neutron energy spectrometer designed on the basis of the collimation scheme of R. Giles. The central counter is surrounded by several counters for anticoincidence; the filling gas is hydrogen. The counter being long and thin, the geometrical effective cross sectional area facing the neutron source is small. To overcome this shortcoming, a multiple anode counter is proposed in which a number of counters are arranged in a form of a hive with specially devised electric circuits. Elementary experiments verified the practicability of this proposed neutron spectrometer. (auth)

9148 MEASUREMENTS OF NEUTRON FLUX BY SHIELDED 'LONG COUNTER.' Hisanobu Kobayashi. Sci. Papers Inst. Phys. Chem. Research (Tokyo) 54: 261-5(Sept. 1960). (In English)

The counting efficiency and directionality of a shielded 'long counter' for neutrons from Ra–Be source were investigated. The efficiencies of the counter with and without deep holes, eight in number, made from the front into the surrounding paraffin body around the BF_3 counter, were found to be 1.9 and 1.7%, respectively. The effect of neutrons scattered by the floor was also investigated. (auth)

9149 MEASUREMENTS OF NEUTRON INTENSITY BY THE USE OF MANGANESE BATH. Hisanobu Kobayashi. Sci. Papers Inst. Phys. Chem. Research (Tokyo) 54: 266-70(Sept. 1960). (In English)

The strength of Ra(100 mc)–Be neutron source was measured by the use of manganese bath in cylindrical tanks of different sizes. This manganese bath method is examined from various points of view. A sample of activated Mn^{56} taken from a water solution of $MnSO_4$ in the form of Mn_3O_4 was measured by a Geiger-Müller counter with end window, and the absolute measurement of Mn^{56} activity was made by the defined solid angle method. The manganese bath consisted of a water solution of 1 mol. per liter of $MnSO_4$. The cylindrical tank had its diameter equal to its height varying in size from 17 to 70 cm in diameter and height. The leakage factor of neutron was obtained by varying the size of the bath tank. The strength of the neutron source measured with a tank 69.3 cm in diameter and height agreed with Belgian assayed value within the error of 10%. (auth)

9150 BF_3 NEUTRON COUNTER. Hisanobu Kobayashi. Sci. Papers Inst. Phys. Chem. Research (Tokyo) 54: 271-3 (Sept. 1960). (In English)

To obtain a BF_3 counter of good performance, it is essential that the counter be filled with pure BF_3. The preparation of $BF_3 \cdot CaF_2$ with a specially designed apparatus and the procedure used for filling a counter with BF_3 are described. The counter thus prepared had the plateau length of over several hundreds volts with the slope of less than 2%. (auth)

9151 CONDITIONS NECESSARY FOR GAMMA-CONDUCTIVITY IN CdS MONOCRYSTALS. I. D. Konozenko, V. I. Ust'yanov, and A. P. Galushka (Inst. of Physics, Academy of Sciences, Ukrainian SSR, Kiev). Soviet Phys.-Solid State, 2: 1436-41(Jan. 1961).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 24725.

9152 ABSORPTION OF INFRARED RADIATION BY ELECTRONS IN n-TYPE SILICON. V. A. Yakovlev (Stalingrad Pedagogical Inst.). Soviet Phys.-Solid State, 2: 1471-5(Jan. 1961).

The equations for the absorption of infrared radiation in n type silicon are derived assuming a mechanism in which scattering of electrons in the conduction band occurs by atomic oscillations. At high temperatures, the absorption coefficient α^0 reduces to $T^{\frac{1}{2}}\omega^{-2}$, where ω is the photon frequency, and at low temperatures and frequencies $\omega \simeq \omega_0$, $\alpha^0 \simeq T^{\frac{1}{2}}\omega^{-3} \exp(h\omega - h\omega_0/2kT)$. The similarities of the equations to the corresponding ones for n type germanium are discussed. (D.L.C.)

9153 EFFECT OF AN ELECTRIC FIELD ON THE SCINTILLATION PROCESS IN CsI(Tl). I. I. Lomonosov and Yu. A. Nemilov. Soviet Phys.-Solid State, 2: 1476-8 (Jan. 1961).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 24726.

9154 INVESTIGATION WITH IONIZATION CHAMBERS FOR THE DETERMINATION OF THE ISODOSES IN PENDULUM IRRADIATION WITH ULTRAHARD X-RAY BEAMS OF A 15-Mev ELECTRON ACCELERATOR-BETATRON. II. INVESTIGATIONS ON "SIDE ELEVATED" PHANTOMS. Franz Heinzler and Harald L. Mohr (Klinik für Medizinische Strahlenkunde, Medizinische Akademie, Düsseldorf). Strahlentherapie, 113: 619-28 (Dec. 1960). (In German)

The isodoses for the ultrahard x radiation of the 15.5-Mev betatron in the "side elevated" bodylike water phantom were measured by means of an ionization chamber with the pendulum angle ±90, ±60, and ±30 degrees, and a pendulum axis depth 5, 10, and 15 cm, and the results were compared on the "lying" phantom. The isodoses were set down and discussed, the dependence of the dosage maximum of the pendulum axis depth was plotted in curves, and the valid factors for these trial conditions for the three pendulum angles to measure the tumor dose communicated. Here also the dose on the tumor from the x-ray value, filter, and depth dose factor can be ascertained in a relatively simple way. (auth)

9155 IONIZATION CHAMBER INVESTIGATIONS ON THE DETERMINATION OF THE ISODOSES IN PENDULUM IRRADIATION WITH ULTRAHARD X RAYS OF A 15-Mev ELECTRON ACCELERATOR BETATRON. III. INVESTIGATION ON THE "HORIZONTAL" PHANTOM FOR THE OBTENTION OF A LARGER IRRADIATION FIELD. Franz Heinzler and Harald L. Mohr (Klinik für Medizinische Strahlenkunde, Medizinische Akademie, Dusseldorf). Strahlentherapie, 114: 103-12(Jan. 1961). (In German)

For the enlargement of the irradiation field of the 15.5-Mev x radiation of the betatron the field of the "block" in the water phantom was measured. With filter 3 the relatively large field is sufficiently homogenized with a pendulum angle of ± 90° and a pendulum axis of 10 cm; resulting in an increased immigration of the dose maximum and an enlargement of the 80% isodose. With a pendulum angle of ± 60° there is with filter 3, corresponding to the widening of the field, an enlarging of the 80% isodose. The possibilities of using these fields are briefly discussed. The calculation of the focal dose from the position of the dose maximum by corresponding pendulum angles by means of roentgen value, filter, and depth dose factor can from earlier reported statements be made with sufficient exactitude. (auth)

9156 DEVICE FOR MEASURING THE THICKNESS OF MATERIALS BY USING RADIOACTIVE PREPARATIONS. V. M. Karpov (N. E. Bauman Technical College, Moscow). Zavodskaya Lab., 26: 1312-16(Nov. 1960). (In Russian)

Variation of the wall thickness of a pipe may be measured by radiation using either a pulse or a steady current. In the first case, the pulsed signal is a function of the linear attenuation coefficient, the dead time of the instrument and the initial flux. Using a steady current (dead time = 0) the change of the initial flux results only in a corresponding change of the output signal which may be easily compensated for electronically; in addition, a fast response is obtained. Accordingly, this system was chosen for designing a practical apparatus. As a source, Eu^{152}, Tu^{170}, and Sr^{90} may be used; the β-radiation of strontium is especially useful for measuring thin walls. A special magnetic holding device was developed for positioning the source inside the pipe. (TTT)

9157 SOLID STATE RADIATION DETECTORS. Proceedings of the Seventh Annual National Meeting, Gatlinburg, Tenn., October 3-5, 1960. IRE Transactions on Nuclear Science, Volume NS-8, Number 1, January 1961. New York, Institute of Radio Engineers, Inc., 1960. 162p. $4.50.

The papers given at the Seventh Annual National Meeting of the Professional Group on Nuclear Science at Gatlinburg, Tennessee, on October 3 to 5, 1960, are presented. The topic of the conference was "Solid-State Radiation Detectors." Twenty-four of the papers are covered by separate abstracts. One was previously abstracted for Nuclear Science Abstracts. (M.C.G.)

9158 IMPROVEMENTS IN AMPLITUDE SELECTING APPARATUS. (to Commissariat a l'Energie Atomique). British Patent 859,672. Jan. 25, 1961.

An amplitude selecting apparatus is designed for classifying electrical pulses in a conductor. The apparatus contains amplitude discriminators, bi-stable circuits, a control line, and anti-coincidence circuits. The advantages of this apparatus are that the time required for analysis and recording can be reduced to 3×10^{-7} sec after the impulse peak, any form of impulses can be analyzed without shaping circuits, and the rate of succession of the events to be analyzed can be increased to 1.3×10^5 shots/sec without sacrifice of accuracy or control. The apparatus should be useful in nuclear physics, e.g., determination of disintegration spectra of radioactive bodies and time-of-flight of particles. (D.L.C.)

9159 NEW ELECTROSTATIC DEVICE FOR DETECTING FISSION PRODUCTS IN GASES. (to Commissariat à l'Énergie Atomique). French Patent 1,188,100. Mar. 9, 1959.

A schematic device for monitoring the short-lived fission products in gaseous reactor coolants is described. A sample of the gas is made to stay in a transit space for such a time that the short-lived fission products krypton and xenon are transformed into ionized decay products, after which the total gas activity is measured. An electrostatic field is then applied in order to collect the ionized nuclei and simultaneously the activity is again measured. The circuitry of the measuring equipment is such that only the radioactivity of the collected nuclei is recorded. (NPO)

9160 METHOD AND MEANS FOR RADIATION DOSIMETRY. J. W. Shulte and J. F. Suttle (to U. S. Atomic Energy Commission). U. S. Patent 2,957,080. Oct. 18, 1960.

A precise dosimeter for γ and x radiations is designed in which a reproducible response to radiation is achieved by controlling the amount of sensitizer. The sensitizer is

present in a halogenated hydrocarbon system and is a leuco base of certain dyestuffs. This patent is related to U. S. Patent No. 2,824,234. (D.L.C.)

9161 ELECTRONIC SYSTEM. G. H. Robison and J. F. Dickson (to U. S. Atomic Energy Commission). U. S. Patent 2,960,687. Nov. 15, 1960.

An electronic system is designed for indicating the occurrence of a plurality of electrically detectable events within predetermined time intervals. The system comprises separate input means electrically associated with the events under observation; an electronic channel associated with each input means, including control means and indicating means; timing means adapted to apply a signal from the input means after a predetermined time to the control means to deactivate each of the channels; and means for resetting the system to its initial condition after the observation of each group of events. (D.L.C.)

9162 METAL RESISTIVITY MEASURING DEVICE. C. J. Renken, Jr. and Ronald G. Myers (to U. S. Atomic Energy Commission). U. S. Patent 2,965,840. Dec. 20, 1960.

An eddy current device is designed for detecting discontinuities in metal samples. Alternate short and long duration pulses are inductively applied to a metal sample via the outer coil of a probe. The long pulses give a resultant signal from the metal sample responsive to probe-to-sample spacing and discontinuities within the sample, and the short pulses give a resultant signal responsive only to probe-to-sample spacing. The inner coil of the probe detects the two resultant signals and transmits them to a separation network where the two signals are separated. The two separated signals are then transmitted to a compensation network where the detected signals due to the short pulses are used to compensate for variations due to probe-to-sample spacing contained in the detected signals from the long pulses. Thus a resultant signal is obtained responsive to discontinuities within the sample and independent of probe-to-sample spacing.

Materials Testing

9163 (HW-65865) THICKNESS MEASUREMENT BY ULTRASONIC FREQUENCY MODULATION. T. G. Lambert (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 28, 1960. 5p. Contract AT(45-1)-1350.

A prototype instrument was designed and built which demonstrates the ultrasonic pulse echo technique of measuring metal thickness from 0.010 to 0.080 in. The instrument is based upon the principle that metal sections, when driven by pulses of vibratory energy, resonate at frequencies dependent upon the thickness of the section. (L.T.W.)

9164 (SCTM-196-60-16) HIGH VELOCITY SHOCK TESTING, EQUIPMENT AND METHODS. Walter W. Walker (Sandia Corp., Albuquerque, N. Mex.). July 11, 1960. 37p.

The need for special high-velocity shock testing is pointed out, and equipment that was developed to meet these needs is discussed. Also discussed is the concept of velocity change and its importance in shock-testing technology. The three types of equipment described are accelerated drop testers, pneumatic actuators, and air guns. Examples of each type and their capabilities and limitations are presented. (auth)

9165 (WAL-TR-830.5/1) SPECTRUM AND CONTOUR ANALYSIS OF ULTRASONIC PULSES FOR IMPROVED NONDESTRUCTIVE TESTING. Otto R. Gericke (Watertown Arsenal Labs., Mass.). Dec. 1960. 19p. (PB-171186).

A technique for obtaining the ultrasonic attenuation/frequency relationship in a single operation is suggested and investigated. This method employs ultrasonic pulses which contain energy over a wide band of frequencies, and uses a spectrum analyzer to detect the frequency dependence of ultrasonic attenuation. (auth)

9166 EXPERIENCES ON THE USE OF NONDESTRUCTIVE TESTING METHODS WITH RADIOACTIVE ISOTOPES. Jozsef Hirling and Karoly Varga (Radioisotope Lab. of the "Csepel" Iron and Metal Works, Hungary). Energia és Atomtech., 13: 513-14(1960). (In Hungarian)

Radiographic methods used at the "Csepel" Iron & Metal Works for determining the integrity of cast and welded structures are described. Large sources, up to 1000 c of Co^{60}, Cs^{137}, and Ir^{192}, are stored in a 10-m-deep well. The control panel of the operating area is provided with safety devices including interlocks which prevent entry into the room when the source is in an operating position. About 70% of tests are performed in the field using portable sources. (TTT)

9167 A METHOD SUITABLE FOR THE MEASUREMENT OF THE THERMAL DIFFUSIVITY OF IRRADIATED MATERIALS. D. Smart (C. A. Parsons & Co. Ltd., Newcastle-upon-Tyne, Eng.). J. Nuclear Materials, 2: 341-9 (Dec. 1960). (In English)

A description is given of a transient method which is suitable for measuring thermal diffusivity of irradiated materials. The time taken for the measurement is short and some of the difficulties normally encountered in handling and machining radioactive material, prior to such a measurement, are avoided. The theory is developed, a prototype test equipment described, and results quoted for brass, steel, natural uranium (unirradiated), copper, and aluminum. For brass, steel, and natural uranium specimens the accuracy is better than ±5% of the accepted values reported in the literature. The accuracy for aluminum and copper could be improved by using longer specimens in a modified apparatus. The measurement is of the macroscopic thermal conductivity, i.e., averaged over an area much greater than that of a single crystallite. (auth)

GEOLOGY, MINERALOGY, AND METEOROLOGY

9168 (AEET/AM/15) FALLOUT OBSERVATIONS IN INDIA AFTER THE FIRST FRENCH ATOMIC TEST IN SAHARA. K. G. Vohra, V. S. Bhatnagar, and C. Rangarajan (India. Atomic Energy Establishment, Trombay). Apr. 1960. 41p. (A/AC.82/G/L.460).

Data are reported on airborne radioactive fall-out and surface deposition of fall-out in India after the French atomic test in Sahara on Feb. 13, 1960. An increase in activity was observed from Feb. 16 to Mar. 20, 1960. The maximum level of deposition at Bombay, deposited between Feb. 17 and 18, was about 170 mc/km^2. This level was observed in the absence of rainfall. The air concentrations of fall-out showed large fluctuations, with a maximum level of about 12 $\mu\mu c/m^3$ of air at Bombay between Feb. 19 and 20. Meteorological interpretations of the data are presented, and estimates of the total radiation dose from fall-out are included. (auth)

9169 (AERE-R-3349) THE DEPOSITION OF FISSION PRODUCTS FROM DISTANT NUCLEAR TEST EXPLOSIONS.

RESULTS TO THE MIDDLE OF 1960. R. N. Crooks, R. G. D. Osmond, E. M. R. Fisher, M. J. Owers, and T. W. Evett (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England and United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Woolwich Outstation, England). 1960. 16p.

Collection of rain-water samples continued at seven stations in the United Kingdom and at 17 stations elsewhere. Samples are collected monthly at Milford Haven, Pembrokeshire, and Abingdon, Berkshire, and quarterly at the other stations and are analyzed for Sr^{89}, Sr^{90}, and Cs^{137}. The total deposition of Sr^{90} in the 12 months ending June 1960 at Milford Haven was 2.55 mc/km^2, compared with 7.1 mc/km^2 in the previous 12 months. Some information is also included on the uniformity of the Sr^{90} concentration in rain over the U.K., on the variation of Sr^{90} concentration with latitude, on the ratio of Cs^{137} to Sr^{90}, and on the seasonal variation of activity in rain. (auth)

9170 (ANL-6199(p.62-65)) FALLOUT TRANSPORT AS DEDUCED FROM MEASUREMENT OF GAMMA-EMITTING RADIOACTIVITY IN AIR. F. P. Gustafson and M. A. Kerrigan.

Filters used to collect air samples were grouped by calendar month, partly ashed, and analyzed for γ-emitting radioactivity by NaI scintillation spectrometry. Data are presented on the concentration of Cs^{137} in air from 1954 through 1957 and from 1958 through May 1960. W^{181} and W^{185} that was present in several shots of the Hardtack series held through July 1958 served to trace low-altitude stratospheric equatorial activity. Rh^{102} formed in a missile detonation at 100,000 feet over Johnston Island in August 1958 was used to follow high altitude equatorial debris. The various fission products found were identified as to time and place of origin. It was concluded that the spring maximum in stratospheric fall-out rate is a real phenomenon that causes the rate of fall-out to vary seasonally. Debris from different geographic locations and altitudes was found to manifest different residence times. That from polar latitudes has the shortest residence time, and equatorial high-altitude fall-out has the longest residence time. (C.H.)

9171 (ANL-6199(p.66-67)) GAMMA-RAY STUDIES ON RADIOACTIVE FALLOUT IN SOIL. P. F. Gustafson, S. S. Brar, and M. A. Kerrigan.

Measurements were made of gross fission product radioactivity and γ-ray emitting fall-out in radioactivity on the ground in soil samples collected from December 1959 through June 1960. Data are tabulated. (C.H.)

9172 (ANL-6199(p.82-84)) I. STUDY OF RADIUM 226 CONTENT OF MIDWEST WATER SUPPLIES. Henry F. Lucas, Jr.

Data are presented on the Ra^{226} content of municipal drinking waters in Illinois. At least one water sample was collected and analyzed from 163 of 165 communities comprising more than 99% of the total population suspected of consuming water with high radium content. Data are summarized on populations in Illinois, Iowa, Missouri, and Wisconsin which consume water at various ranges of Ra^{226} content. (C.H.)

9173 (ANL-6199(p.85-87)) Ra^{228}(MESOTHORIUM I) IN MIDWEST WELL WATERS. Douglas P. Krause.

Samples of midwestern drinking water having Ra^{226} levels equal to or greater than 4 $\mu\mu$c/liter were analyzed for Ra^{228} content. These waters were obtained from wells penetrating deep sandstone formations. Data are tabulated. (C.H.)

9174 (ANL-6199(p.115-18)) APPENDIX III. THE RaD CONTENT OF SOME POTABLE WATERS IN ILLINOIS. Richard B. Holtzman.

Measurements were made of the Pb^{210} content of some potable waters from Illinois. Results are compared to the Ra^{226} content. Data are tabulated. (C.H.)

9175 (CRER-972) MOVEMENT OF RADIOACTIVE WASTES THROUGH SOIL. II. MEASUREMENT OF DIRECTION AND EFFECTIVE VELOCITY OF GROUND WATER MOVEMENT. W. F. Merritt (Atomic Energy of Canada Ltd., Chalk River, Ont.). Jan. 1961. 18p. (AECL-1161).

The results of an experiment to determine the direction and effective velocity of ground-water flow in an area of Perch Lake Swamp are given. Results obtained using tritium, S^{35} and fluorescein dye as tracers are compared. Sulfur-35 moved at a rate of 6.7 in. per day, tritium moved 5% faster, and fluorescein 20% more slowly. Although reasonable values for the effective velocity were obtained, the flow pattern is complex. (auth)

9176 (CF-58-5-98) USE OF LIGHT AIRCRAFT FOR SURVEYING FOR RADIOACTIVE GROUND CONTAMINATION. D. M. Davis and H. H. Abee (Oak Ridge National Lab., Tenn.). May 21, 1958. 22p.

The recent Windscale incident has emphasized the need for available light aircraft and proper instrumentation for aerial surveys following a release of large quantities of airborne radioactive materials. Early tests (1951 and 1955) are reviewed, and the program now in effect at the Oak Ridge National Laboratory is presented. (auth)

9177 (HW-67269) DETERMINING SOIL MOISTURE WITH HUMIDITY CELLS. J. D. McCormack (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 1, 1960. 8p. Contract AT(45-1)-1350.

The use of El-Tronics humidity cells in determining soil moisture was investigated for two types of soil, washed Ottawa sand and Ringold formation soil, which contains about 40% clay. The cells provided a usable change of resistance from 5 to 17 wt.% water for the high clay soil, but were unsuitable for determining the moisture content of the sand. Individual calibration would be necessary for each type of soil. For selected types of soil the humidity cells provide a simple nondestructive means of determining soil moisture content. The useful range is limited to conditions which produce moisture tensions greater than approximately 10 atm. (auth)

9178 (HW-67280) WATER SAMPLING AT DEPTH IN WELLS. J. R. Raymond (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 9, 1960. 12p. Contract AT(45-1)-1350.

Equipment was developed and fabricated for taking multiple well-water samples at selected depths below water surface. The samplers consist of standard 500 cc glass sample containers closed by solenoid valves. Sample containers and valves are clamped to spacer pipes. Multiple samplers are run by being connected together with quick connect couplings on the ends of the spacer pipes. An electrical cord with plugs on both ends is also clamped to each spacer pipe and allows electrical continuity between adjacent samplers. A steel armored electrical cable is used for lowering and raising the samplers in wells and for conducting electrical current to the solenoid valves. Any reasonable number of samplers may be run in tandem and samples may be taken any time after the samplers are positioned in a well. The samplers were satisfactorily tested at depths of 500 ft below water surface (about 240 psi). Above 50 ft below water surface, the sampler container must be evacuated before lowering into the well to assure an adequate size sample. This multistage sampler system provides an easy, simple, and positive method of depth sampling Hanford water monitoring wells. (auth)

9179 (HW-67415) EVALUATION OF EARTH SAMPLES FROM CHURN-DRILLED WELLS. Donald J. Brown (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 19, 1960. 12p. Contract AT(45-1)-1350.

An evaluation is presented of earth samples provided by the bailer method, which produces mud and chips of crushed rock churned up during drilling, as compared with core samples produced by use of the drive-barrel well drilling method. It was concluded that results of analyses gave no basis for suspecting the soil characteristics represented by the samples. (J.R.D.)

9180 (NP-9826) NOTA SOBRE UMA OCORRENCIA DE TORITE EM ALTER PEDROSO. Memoria No. 29. (Note on the Occurrence of Thorite at Alter Pedroso (Portugal). Report No. 29. João T. Pacheco and Raul A. D. Gomes (Portugal. Junta de Investigacoes do Ultramar, Lisbon). 1960. 25p.

The first known occurrence of thorite in Portugal is reported. The mineral was found as small dark reddish-brown euhedral grains scattered in a soil sample from the hyper-alkaline syenite region of Alter Pedroso, in prospecting for radioactive materials. Zircon, riebeckite, aegirine, feldspar, biotite, magnetite (all of these common minerals of the hyper-alkaline syenite), and a few other unidentified minerals were found in the soil associated with thorite. This suggests the weathering of a local pegmatitic differentiation of the syenite as the origin of the thorite. Microscopic examination shows the mineral to be only partially metamict, and it is probably altered to a variable degree. Euhedral grains are constituted by several nearly colorless anisotropic nuclei (n_p near 1.69, n_g near 1.71, and sometimes anomalous B+ with variable 2V averaging 10^0) surrounded by a golden-brown isotropic material (n about 1.67). Specific gravity determinations were somewhat impaired by zircon inclusions and led to a value of 4.79. The chemical composition was determined by emission and x-ray fluorescence spectrography and shows a high yttrium content. A partial semiquantitative analysis gave the following results: ThO_2 (58.0%), SiO_2 (14.5%), Fe_2O_3 (2.5%), Y_2O_3 (2.5%), CaO (1.1%), U_3O_8 (0.5%), and PbO (0.2%). The elements Be, Mg, Al, Mn, and P were also detected. X-ray-powder patterns obtained before and after heating the sample to 1000°C for 1 hr in air confirmed the mineral to be only slightly metamict and showed that the tetragonal phase still prevails above 950°C. Calculations based on these patterns led to a tetragonal unit cell with $a_0 = 7.05 \pm 0.01$ A, $c_0 = 6.27 \pm 0.01$ A, and $c_0/a_0 = 0.889$. (auth).

9181 (NYO-8920) THALLIUM IN METEORITES. I. ISOLATION PROCEDURES. Hamed M. El-Badry (Carnegie Inst. of Tech., Pittsburgh). II. SPECTROCHEMICAL DETERMINATION. Edwin S. Hodge and William K. Baer (Mellon Inst., Pittsburgh). III. THALLIUM CONTENT OF METEORITES. Hamed M. El-Badry and Truman P. Kohman (Carnegie Inst. of Tech., Pittsburgh). Dec. 20, 1960. 48p. Contract AT(30-1)-844.

Procedures for the separation and concentration of microgram to nanogram (10^{-9} g) amounts of thallium from gram amounts of galena and meteoritic metal, sulfide, and silicate phases were developed and are described. The thallium is extracted from aqueous bromide or chloride solutions of moderate acidity using diethyl ether. A device for elimination of the large volumes of solvent by dropwise evaporation is described. Organic matter in the residue is destroyed by treatment with aqua regia, and the thallium in the residue is converted to the nitrate for spectrochemical or mass-spectrometric examination. The presence of thallium in the residue is tested by the Rhodamine B test. Using these procedures, samples of thallium were isolated from samples of galena of unidentified origin, galena concentrate from Ivigtut, Greenland, metal from Canyon Diablo siderite, troilite from Canyon Diablo siderite, and the Plainview chondrite. At least one sample of each was used to test the presence of thallium by the Rhodamine B test. Another sample of each was used for the development of quantitative spectrochemical determination of the thallium content, from which the thallium concentrations in various meteorites were calculated. A third sample of each was reserved for mass-spectrometric determination of the isotopic composition of the thallium. (auth)

9182 (RM-2617(RAND)) GEOLOGICAL COVERING MATERIALS FOR DEEP UNDERGROUND INSTALLATIONS. S. M. Genensky and R. L. Loofbourow (RAND Corp., Santa Monica, Calif.). Aug. 4, 1960. 59p.

An examination was made of twelve different geological configurations, illustrated by as many selected areas of the United States, which might provide desirable sites for large underground installations. A primary consideration is the ability of such a configuration to attenuate appreciably blast waves generated by the ground burst of a nuclear weapon. Results indicate that the overburden (i.e., the material which lies between the roof of the installation and the surface of the earth) need not necessarily be composed of hard, competent rock. Broken rock, shale, and other uncompacted rock may be more effective as blast-wave attenuators. A method is suggested for providing protection in the high-frequency range to an underground structure, in addition to that already provided by the natural overburden. (auth)

9183 (RME-1067(Rev.)) DIAMOND DRILLING IN THE SOUTHERN BLACK HILLS, FALL RIVER COUNTY, SOUTH DAKOTA. Ronald C. Bartley (Grand Junction Operations Office. Production Evaluation Div., AEC). Oct. 1955. 29p.

During the winter of 1954 to 1955, a total of 12,472 feet was drilled in 42 holes in two separate areas of the southern Black Hills about 8 miles northeast of Edgemont, South Dakota. The drilling was done to corroborate the results of a surface resistivity survey, to develop ore guides applicable to subsurface exploration, and to gain a better understanding of the regional changes in lithology. Carnotite-type ores are found in the sandstones of the Dakota and Fall River formations of the Inyan Kara group of Early Cretaceous age and are analogous in occurrence to secondary ores of the Salt Wash sandstone member of the Morrison formation of Late Jurassic age on the Colorado Plateau. Changes in lithology are believed to be the most important single factor in ore deposition. Tectonic and sedimentary structures play a major role in ore deposition and, where both of these factors reach an optimum, ore deposition appears most favorable. (auth)

9184 (TID-6947) PROGRAM OF THE UNITED STATES GOVERNMENT IN ATMOSPHERIC RADIOACTIVITY. George T. Anton (Atomic Energy Commission, Washington, D. C.). Nov. 7, 1960. 14p.

The current program of fall-out studies sponsored by the AEC and other federal agencies is outlined. Aims and objectives of the program are discussed. (C.H.)

9185 (TID-11711) RAIN SCAVENGING OF PARTICULATE MATTER FROM THE ATMOSPHERE. Technical Progress Report No. 2. A. Nelson Dingle (Michigan. Univ., Ann Arbor. Coll. of Engineering). Jan. 1961. 47p. Contract AT(11-1)-739. (UMRI-2921-1-P).

The design and construction of an aerodynamic raindrop sorter are reported. Calibration and testing of this device remains to be done. An effort was made, by the use of expedient measures, to obtain samples of rain according to drop size. Experimentation with such measures was conducted, and the nylon-net technique proved to be most practical, although it was only partially successful. Some results of this effort are presented. Raindrop-size distributions are presented and related to raingauge records. Coordination of research plans with other research groups and efforts has progressed, and the results are discussed. (auth)

9186 (AEC-tr-4342) TRITIUM IN THE INVESTIGATION OF SUBTERRANEAN WATERS. F. A. Alekseev, G. P. Bol'bek, V. N. Soifer, N. A. Vasil'eva, V. N. Maidebor, E. V. Sokolovskii, and N. N. Shan'gin. Translated from Report No. RICC/318 presented at the Conference on the Use of Radioisotopes in Physical Sciences and Industry, Copenhagen, September 6-17, 1960. 16p.

Results are reported from investigations of the motion of underground waters in which tritium was used as a tracer. Applications of the method are reported in studies of the motion of compressed water along a stratum in the process of development of petroleum deposits and in determinations of the rate of filtration of compressed waters along the deposit. (C.H.)

9187 (AEC-tr-4413) DATING WITH C^{14}. A. P. Vinogradov. Translated from Report No. RICC/315 presented at the Conference on the Use of Radioisotopes in Physical Sciences and Industry, Copenhagen, September 6-17, 1960. 17p. (Includes Original 144p.).

A method is described for determining the absolute age of geological and archeological samples by counting the beta activity of C^{14}. The method employs a proportional counter with CO_2 and ethane used as the counting gas. Results are included from age determinations on a variety of samples. (C.H.)

9188 (JPRS-7045) LITERATURE ON METEOROLOGY, HYDROLOGY AND OCEANOGRAPHY FOR 1959. Translation of an article from Meteorol. i Gidrol., No. 5, 56-8(May 1960). Translated by U. S. Joint Publications Research Service, Washington, D. C. November 1960. 11p. (CSO: 4683-N/1)

This bibliography includes 39 references on hydrology, meteorology, and oceanography. (J.R.D.)

9189 (JPRS-7469) DETERMINATION OF ANALOGY BETWEEN THE FIELDS OF METEOROLOGICAL ELEMENTS BY MEANS OF THE ELECTRONIC COMPUTER "POGODA." N. I. Zverev and D. A. Ped'. Translated from Meteorol. i Gidrol., No. 10, 14-18(1960). 8p.

A method is described which was used to improve the Bagrov estimation method of field analogy. Three parameters were chosen to estimate the analogy: ρ, ρ_φ, and ρ_λ. The value ρ characterizes the qualitative aspect or sign of the field, and the parameters ρ_φ and ρ_λ are the position of the anomaly centers and the field gradient direction of the meteorological elements. Computations were made for the analogy of the anomaly fields of mean monthly air pressure at sea level for 69 years. The parameters of the analogy were computed separately for each January for 20 years. An analysis of the data showed that the degree of analogy to the initial anomalies for the parameters varies widely, almost from -1 to $+1$. The frequency of recurrence of the different gradations is described by distribution curves. The best analogy of the series with respect to the proposed criteria is shown in the distribution curves in which $\rho = 0.7696$, $\rho_\varphi = 0.7141$, and $\rho_\lambda = 0.5279$. (B.O.G.)

9190 (JPRS-7471) LITERATURE ON METEOROLOGY, HYDROLOGY, AND OCEANOGRAPHY IN 1959. Translated from Meteorol. i Gidrol., No. 10, 55-8(1960). 12p.

A bibliography is presented on meteorology, hydrology, agrometeorology, and oceanography. The references are taken from articles which appeared in Russian scientific and technical journals during 1959. 110 references. (C.W.H.)

9191 THE RADIOACTIVITY OF SOME CARBON DEPOSITS OF THE R.P.R. G. Atanasiu and M. Soroiu. Acad. rep. populare Romîne, Inst. fiz. atomică şi Inst. fiz., Studii cercetări fiz., 11: 745-51(1960). (In Rumanian)

The results of the measurement of the uranium concentration in some carbon samples of Rumania are given. These samples were chosen from carbon with radioactivity that was first determined with the aid of a counter with a Geiger-Mueller tube. The measurements were made by two different methods: counter arrangement with a Geiger tube and electrometer with an ionization chamber. For the samples analyzed concentrations between 96.3×10^{-6} and 330×10^{-6} g uranium/g carbon ashes and from 17.2×10^{-6} to 29.0×10^{-6} g uranium/g carbon were found. (tr-auth)

9192 METHOD OF URANIUM PROSPECTING IN A MINING DIVISION. Henri G. Carrat. Ann. mines, 135-54 (1959). (In French). (CEA-1247)

Several methods developed by the Grury Mining Division of the C.E.A. for uranium prospecting in the Morvan region of France are summarized. Modifications made in the methods during 12 years, including applications of radiometric techniques, are discussed. A range of field tests that permit an advanced reconnaissance under the soil to be made before mining is begun is described. (M.C.G.)

9193 THE REDDENING OF MINERALS IN URANIUM-BEARING VEINS. Yu. M. Dymkov and B. V. Brodin. Atomnaya Energ. 10: 35-42(Jan. 1961). (In Russian)

Various types of iron carbonate hematization (siderite, ankerite, iron mangano-calcite) in uranium bearing veins are described. The hematization may be of various origins. It may be related to iron carbonate oxidation as a result of chemical interactions with hydrothermal solutions or to the mechanical displacement of fine particles in hematite. (tr-auth)

9194 EXAMINATION OF RADIOACTIVE ATMOSPHERIC DUST PARTICLES COLLECTED AFTER THE SAHARA NUCLEAR EXPLOSIONS. F. Demichelis and C. Oldano (Politecnico, Turin). Atti accad. sci. Torino. I. Classe sci. fis., mat. e nat., 94: 900-10(1959-60). (In Italian)

Radioactive samples, collected by the filtration of atmospheric air in Naples after the nuclear explosions in the Sahara, were analyzed with a NaI(Tl) scintillation spectrometer and a 100-channel analyzer. The collection data and the results of the analysis are reported. The energy spectra obtained allowed the identification of some artificial γ emitters. (auth)

9195 RESULTS OF YEAR'S MEASUREMENT OF FALLOUT AFTER STOPPING OF NUCLEAR TESTS. Vilém Santholzer (Charles Univ., Prague). Československ. časopis pro fysiku, 10: 216-18(1960). (In Czech.)

A year's measurement of the fall-out after nuclear tests were stopped showed that the amount of fall-out recently decreased substantially and settled at a value of millicurie per month in order of magnitude. In the first few months after the stopping of tests, values up to two orders higher

were measured. The cumulative activity for the first half year after the cessation of tests (up to April 30, 1959) was 121 mc/km^2, and for the second half year (up to October 30, 1959), the activity was only 54 mc/km^2. A permanent decrease in fall-out probably came about since not one signal activity occurred during the last three months. The average daily activity in October 1959 was only 0.07 mc/km^2. The cumulative activity over the whole year after the cessation of tests (up to October 31, 1959) was 104 mc/km^2. The relatively long time taken to clear the troposphere of man-made radioactivity was apparently caused by the contamination of the lower strata of the stratosphere. (auth)

9196 THORITE FROM AN ALKALI COMPLEX OF THE VISHNEVYE HILLS IN THE URALS. A. G. Zhabin and M. E. Kazakova. Doklady Akad. Nauk S.S.S.R., 134: 164-7 (Sept. 1, 1960). (In Russian)

The specific gravity of thorite samples varied from 4.31 to 4.80. The formula is $ThSiO_4 \cdot 1.74\ H_2O$ from chemical analyses. The interatomic distances in the natural thorite were found to be close to the parameters found for synthetic thorite (a = 7.142 and C = 6.327 A). It is pointed out that 1 to 1.5 molecules of water are associated with thorite minerals, > 1.5 H_2O for uranothorite and ferrothorite, 4.0 H_2O for hydrothorite, and 6.0 H_2O for thorogummite. Thorianite (a uranate of thorium) was also found as an accessory mineral in the nepheline-syenite intrusion. The discovery of accessory thorium minerals in alkali strata indicates that the geochemistry of thorium in similar alkali complexes should be investigated further. (TTT)

9197 THORIUM, URANIUM AND ZIRCONIUM CONCENTRATIONS IN BAUXITE. J. A. S. Adams and K. A. Richardson (Rice Inst., Houston, Tex.). Econ. Geol., 55: 1653-75(Dec. 1960).

Twenty-nine samples of bauxites from different locations were analyzed for thorium and uranium by gamma spectrometric, alpha counting, and wet chemical methods. The thorium concentrations ranged from 5.0 to 131 ppm and averaged 48.9 ppm. The uranium concentrations ranged from 2.7 to 26.7 ppm and averaged 11.4 ppm. The thorium-to-uranium ratios ranged from 1.5 to 20.9, with an average value of 5.1. Zirconium determinations on some of the bauxites gave values ranging from 0.02 to 0.65% zirconium, and averaging 0.09% zirconium. The thorium, uranium, and zirconium contents of the bauxites were related to the type of source rock. Bauxites derived from nepheline syenites contained more thorium and uranium than bauxites derived from other rock types; bauxites derived from basic igneous rocks had the lowest thorium and uranium concentrations, and bauxites derived from carbonate rocks had the lowest thorium-to-uranium ratios. The greatest concentrations of zirconium were found in bauxites derived from nepheline syenites, and bauxites derived from carbonates contained the lowest concentrations of zirconium. A study of samples from alumina plants treating Surinam and Arkansas bauxites showed that during the process over 70% of the thorium and uranium in these two bauxites is concentrated into the red mud, and the alumina contains very small amounts of these elements. This study also indicated that much of the thorium and uranium in bauxites occurs in either primary or secondary resistate minerals. (auth)

9198 THE ORIGIN OF THUCHOLITE. Henry R. Hoekstra and Louis H. Fuchs (Argonne National Lab., Ill.). Econ. Geol., 55: 1716-38(Dec. 1960).

The origin of the organic material and the mechanism of formation of the organo-uranium complex in thucholite from the Besner Mine, Parry Sound District, Ontario, were investigated. Results indicated that thucholite was formed by the action of aqueous solutions containing organic material, possibly as an oil-in-water emulsion. Uranium, lead, and other relatively soluble oxides were leached from uraninite, whereas aluminum, iron, magnesium, and silica were deposited in the thucholite. The separation of uranium from thorium and the rare earths is believed to have occurred by oxidation of tetravalent uranium to the more soluble hexavalent oxidation state. Oxidation of uranium and the organic fraction of thucholite in an otherwise reducing environment is assumed to be due to the action of radiation decomposition products of water and the hydroxyl radical and/or hydrogen peroxide. Oxidation of the organic material may also be due to subsequent reaction with hexavalent uranium. The liquid and solid hydrocarbons, by virtue of their optical activity, are shown to be of plant or animal origin, rather than polymerization products of methane and other low-molecular weight gases. The hydrocarbons are probably not contemporaneous with the organic fraction of thucholite. (auth)

9199 COMMENTS REGARDING THE BLIND RIVER (ALGOMA) URANIUM ORES AND THEIR ORIGIN. Frank R. Joubin. Econ. Geol., 55: 1751-6(Dec. 1960).

The origin of the Algoma (Blind River) uranium deposits is discussed. It appeared reasonably certain that the uranium minerals and pyrite were present prior to the folding, faulting, and cataclastic fracturing of the ore-bearing rocks. Over several square miles, averaging about 10 ft in thickness and totaling several hundred million tons, the uranium-bearing material was found to average about 0.12% U_3O_8 with amazing consistency and despite considerable variation in detail. This suggested that the uranium mineralization of the Algoma field was syngenetic and was introduced by ground-water solutions that had leached and concentrated the uranium content from probably low-grade Archean "basement" areas. (M.C.G.)

9200 PRINCIPLES OF RADIOACTIVE LOGGING. János Kakas (Radioisotope Lab. of the "Csepel" Iron and Metal Works, [Hungary]). Energia és Atomtech., 13: 510-12 (1960). (In Hungarian)

No single method is able to clarify all the problems raised in the deep-hole logging operations. Determination of many properties such as specific resistivity, potential of induced fields, heat conductivity, dielectric constants, etc., is to differentiate between minerals. Radioactivity measurements are very useful because they can be performed in steel-lined drill holes which would affect other measurements. The neutron-γ measurements, which involve the determination of the energy of the γ quantum resulting from the inelastic interaction between the neutron radiation and the atoms of the material, are widely employed. Thus the data obtained from measuring the intensities obtained when a neutron source and a detector are introduced into the hole determine directly the atomic number, the mass number, and the cross section of the elements in the surrounding minerals, giving their approximate composition. Despite the technical difficulties, scintillation counters are better suited for this type of measurement than G-M counters. (TTT)

9201 ON THE RELIABILITY OF THE "LEAD" AGES OF MONAZITES. S. L. Danilevich (Khlopin Radium Inst. Leningrad). Geokhimiya, No. 8, 736-47(1960). (In Russian)

As a result of studying the lead-isotope ages of 59 ancient Ukrainian monazites it was possible to state the dependence of various ages on the values of the coefficient A. $A = (Pb^{207} \cdot 100)/(Pb^{H}Th/U)$, where Pb^{207} and Pb^{H} are the content, respectively, in per cents of lead from monazite

Pb^{207} and nonradiogenic lead and (Th)/(U) is the relation of thorium to uranium in monazite. Monazites, possessing $A \gg 1$, showed, as a rule, well coinciding ages. In the case of $A < 1$, the monazites had different ages. It is shown that in the case of $A > 1$ the ages of the monazites have much smaller analytical errors than in the case of $A < 1$. (auth)

9202 ZONALITY OF GAMMA-FIELDS AND ACCESSORY MINERALS IN THE GRANITE MASSIFS OF THE ALTAI. N. N. Amshinskiĭ. Geol. i Geofiz., Akad. Nauk S.S.S.R., Sibir. Otdel., No. 1, 38-51(1960). (In Russian)

Radiometric investigations and study of accessory minerals of various facies zones of granite massifs show that γ fields of massifs have a zonal structure, stipulated by primary zonality in the distribution of accessory minerals, containing radioactive elements. The discovered regularity is offered for the determination of the depth of formation and erosion levels of granitoid intrusives. (auth)

9203 THE BASE OF THE THEORY OF PHOTONEUTRON METHODS OF ROCK AND ORE INVESTIGATIONS. E. M. Philippov. Geol. i Geofiz., Akad. Nauk S.S.S.R., Sibir. Otdel., No. 6, 94-105(1960). (In Russian)

Superthermal and thermal neutron density distributions, appearing when the nuclei of some elements constituting rocks and ores were gamma irradiated, are given. Media containing hydrogen and other elements which absorbed neutrons strongly were examined. The expressions for neutron density distribution in homogeneous media, as well as those with cylindrical boundary limits (an idealized well analog), are given. (auth)

9204 ON THE COLORATION OF MONAZITES. G. T. Kravtchenko. Geol. i Geofiz., Akad. Nauk S.S.S.R., Sibir. Otdel., No. 7, 80-90(1960). (In Russian)

Differently colored monazites of various countries were studied and it was concluded that the character of the absorption spectrum of this mineral was determined by neodymium and praseodymium, but the main reason of coloration was iron. Various tints in mineral coloration were conditioned by ferric oxide and ferrous oxide content. (auth)

9205 THE RUBIDIUM–STRONTIUM METHOD. H. Hintenberger. Geol. Rundschau, 49: 197-224(1960). (In German)

A review is presented on the Rb/Sr method for time measurement in geology. The discussion begins with the basis for the method and continues to the half life of Rb^{87}, isotopic abundance in normal strontium and the strontium isotope method, quantitative determination of rubidium and strontium in minerals, suitable minerals, and reliability and precision of the method. It is stated that the Rb/Sr method is at least equal in reliability to the U/Pb and K/Ar methods, and is being used more and more for dating. (119 references.) (T.R.H.)

9206 ASPECTS OF THE DEPOSITION OF RADIOACTIVE AND OTHER GASES AND PARTICLES. A. C. Chamberlain (Atomic Energy Research Establishment, Harwell, Berks, England). Intern. J. Air Pollution, 3: 63-88(Oct. 1960).

Studies on the deposition of radioactive aerosols from the air to the ground are described. Fission products may be found in the vapor form, as is I^{131}, or adsorbed on very small particles (condensation nuclei). The particles are too small to have appreciable terminal velocity but are subject to Brownian motion and to electrostatic forces, by which means they are deposited. The terminal velocities are about 10^{-4} cm/sec or less, but the dry deposition to surfaces is about 10^{-2} to 10^{-1} cm/sec. Activity in this form is also subject to deposition in rain. Velocities of deposition of 1 cm/sec are found for the dry deposition of I^{131} vapor. The modes of deposition are by diffusion, eddy diffusion in free air, and molecular diffusion across laminar boundary layers. (B.O.G.)

9207 SCAVENGING ACTION OF RAIN ON NONWETTABLE PARTICULATE MATTER SUSPENDED IN THE ATMOSPHERE. C. S. Pemberton (Atomic Weapons Research Establishment, Aldermaston, Berks, England). Intern. J. Air Pollution, 3: 168-78(Oct. 1960).

A mechanism of capture of a nonwettable particle by a liquid drop (in which capture is opposed by the surface tension of the drop) is investigated, and a nondimensional number called the "penetration factor" is derived, together with a condition for the retention of the particle by the drop. The equations of motion of a particle moving under Stokes' law of resistance in the velocity field caused by potential flow around a sphere are integrated numerically. The collection efficiencies so obtained are shown to depend not only on the inertia parameter, as demonstrated by previous work on wettable particles and droplets, but also upon the penetration factor and a nondimensional form of the retention condition. Together with experimentally determined drop-size distributions and the application of a statistical procedure, the results are used to determine the fraction of particles of a given size removed by rainfalls of several intensities and durations, and a nomograph is constructed. An application is made to determine the total amount of material rained-out from a particulate cloud having an empirical particle-size distribution. The effectiveness of the scavenging action of rain is shown to be considerably reduced for nonwettable particles. (auth)

9208 NATURAL RADIOACTIVITY IN GROUND WATER SUPPLIES IN MAINE AND NEW HAMPSHIRE. Benjamin M. Smith, Werner N. Grune, Frederick B. Higgins, Jr. (Georgia Inst. of Tech., Atlanta), and James G. Terrill, Jr. J. Am. Water Works Assoc., 53: 75-88 (Jan. 1961).

The experimental value of 3.798 days for the half life of the gaseous radioactivity encountered in ground waters of Maine and New Hampshire shows that the activity was from Rn^{222}, which has a half life of 3.825 days. But the nature of the analytic method used does not preclude the existence of other gaseous radioactive isotopes in these ground waters. In Maine, 99.2% of all the water samples from drilled wells and 84% of all those from dug wells contained concentrations of Rn^{222} and daughter products exceeding 2000 $\mu\mu c/l$. The frequency distributions and average activities of radon in Maine and New Hampshire were not significantly different. For large areas, the depth of a well did not significantly influence the radon activity of well water. But when the area used as a basis for comparison was reduced in size to only a few square miles, radon activity was found to vary linearly with depth. In New Hampshire, the Ra^{226} activity decreased with increased depth; in Maine, a trend could not be established. The average radon activities of drilled and dug wells in several geographic and geologic zones were found to be statistically different. In Maine, drilled wells contained significantly greater concentrations of radon than did dug wells. There appears to be a continuing high level of radon activity associated with the drilled wells within a relatively narrow band of geologic formations following the general outline of the Fitchburg Pluton in New Hampshire and the Waterville Formation in Maine. Limited studies on the variation of radon activity with pumping time showed that radon activity varied with the duration of pumping and the idle period between pumpings. In both Maine and New Hampshire, Rn^{222} was found to be in excess of equilibrium with the Ra^{226} present in the ground waters. (auth)

9209 A REPORT ON THE DEVELOPMENT OF URANIUM MINES BY THE ATOMIC FUEL CORPORATION. Hidekatsu Misawa (Atomic Fuel Corp., [Tokyo]). J. Atomic Energy Soc. Japan, 2: 758-66(Dec. 1960). (In Japanese)

The Atomic Fuel Corporation has exerted a great effort for the development of uranium mines in this country since its establishment in 1956. The prospecting has so far been centered on the uranium deposits stretching round Ningyotoge Mine. The underground prospecting investigation on the feasibility of industrialization of the mine has been done with similar methods of ordinary metal mines. Moreover, a suitable drifting method was carried out in conjunction with the progress of prospecting on sedimentary uranium deposits. Although there were many difficulties for the ore reserve calculations, because of the wide varieties of the seam thickness and the grades of ores, a suitable method was applied to the calculation as a result of research. At present, the stoping method is in the testing stage as the type of the deposit is different from those in other parts of this country and in the world. As preliminary testing two stoping methods, namely the pillar method and the long-wall method using the iron props and caps of the ordinary coal mines, were tested and brought about a success. Aiming at the raising of the efficiency, excavation and face conveying methods have been put under testing. For the safety of the mine, attention was given to the special nature of the mine as a nuclear source material producing mine and a special policy was applied in addition to those of the ordinary metal mines. (auth)

9210 CRUSTAL STRUCTURE FROM THE NEVADA TEST SITE TO KINGMAN, ARIZONA, FROM SEISMIC AND GRAVITY OBSERVATIONS. W. H. Diment (U. S. Geological Survey, Washington, D. C.), S. W. Stewart, and J. C. Roller. J. Geophys. Research, 66: 201-14 (Jan. 1961).

The time of the first arrival of seismic waves generated by explosions at the Nevada Test Site and recorded along a 300-km line southeastward through Kingman, Arizona, is expressed as $T_0 = \Delta/5.2$, $T_1 = 0.34 + \Delta/6.15$, and $T_2 = 5.82 + \Delta/7.81$, where time is in seconds and the shot-detector distance (Δ) is in kilometers. Assuming constant velocities for the layers, the thicknesses are $H_0 = 1.7$ km, $H_1 = 26.7$ km, and $H_0 + H_1 = 28$ km (below a 1-km datum). The average Bouguer anomaly is about −120 milligals, and the average elevation is about 1.1 km. Seismograms were examined for P waves, indicating the presence of other discontinuities within and below the H_2 layer, but the separation between seismic stations was too great to establish the presence of such discontinuities. A questionable alignment of weak arrivals following the T_2 refraction time by less than 1 sec may indicate the presence of a discontinuity below 28 km. Fair alignments of strong second arrivals in the range 200 to 400 km might be interpreted as direct P waves or channel waves in the H_1 layer. (auth)

9211 THE MARY KATHLEEN URANIUM PROJECT. A. Nelson. Mine & Quarry Eng., 46-54(Feb. 1960).

A description is given of uranium mining and milling methods at the Mary Kathleen Mine in the Cloncurry-Mt. Isa district of Queensland, Australia. The discovery of this property and its development are outlined. The deposit occurs in highly altered meta-sediments in the corella beds of lower proterozoic age. Because of the considerable internal waste in the deposit, it was necessary to devise a selective mining method which would keep dilution to the lowest possible level. The mining, haulage and handling, premilling program, drilling, and blasting are discussed. (M.C.G.)

9212 RADIOACTIVE FALL-OUT IN ISRAEL RESULTING FROM THE NUCLEAR TESTS IN THE SAHARA DESERT. Y. Feige (Atomic Energy Commission, Tel-Aviv, Israel), E. Shalmon, J. Vardi, J. R. Gat (Gutmann), and Y. L. Tokatly. Nature, 189: 90-5(Jan. 14, 1961).

On February 13 and April 1, 1960, nuclear test devices, reportedly in the kiloton range, were exploded in southern Algeria. These tests followed a prolonged period during which no nuclear tests were conducted, with the result that fall-out of short-lived fission products had decreased to a very low level. The tests offered an opportunity of observing fall-out from isolated and well-defined sources of activity in this area. Radioactive materials resulting from those tests were first picked up by the Israel Fall-out Monitoring Network on February 17, and were repeatedly observed again during the following months. The interpretation of the resulting fall-out deposition pattern in the light of the meteorological data gives some insight into the movement of radioactive clouds and their mode of deposition of activity. Data are presented graphically. (auth)

9213 OBSERVATIONS OF FALL-OUT IN INDIA DURING THE PERIOD OF CESSATION OF NUCLEAR TESTS. K. G. Vohra and V. S. Bhatnagar (Atomic Energy Establishment, Trombay, India). Nature, 189: 286-8(Jan. 28, 1961).

A rise in airborne radioactivity was observed in India soon after the completion of high-yield tests carried out in the polar regions in October 1958. This increase continued and reached a maximum after about 4 months. The activity decreased with a half life of about 40 days, suggesting residence time in the atmosphere of about 60 days. Information on the relative proportions of fall-out debris from old tests and the October 1958 polar tests was provided by a study of the ratio of Zr^{95} and Cs^{137} activities in samples of rainwater collected between December 1958 and September 1959. The mean residence time in the atmosphere estimated from this ratio was also found to be about 60 days. Estimates were made of the external γ-radiation dose. Results are tabulated. (C.H.)

9214 NATURALLY OCCURRING ALPHA-ACTIVITY OF DRINKING WATERS. R. C. Turner, J. M. Radley, and W. V. Mayneord (Royal Cancer Hospital, London). Nature, 189: 348-52(Feb. 4, 1961).

The Ra^{226} content was measured in samples of 71 drinking waters from various locations in Great Britain. Measurements were also made on the content of Rn^{222} and Ra^{224} when present. The experimental procedure is described, and results are tabulated. The mean daily intakes of α activity resulting from drinking water was calculated per head of population. Data on daily intakes of natural α activity in water are compared to published figures of the artificial β and γ activity due to the presence of Sr^{90} and Cs^{137} in drinking waters in Great Britain. The pattern of distribution was found to be quite different since fission products appear at their highest levels in surface waters whereas ground waters have extremely low contents of fission products but high values of natural α activity. (C.H.)

9215 DETERMINATION OF THE VERTICAL EXCHANGE COEFFICIENT IN THE LOWER ATMOSPHERE BY SIMULTANEOUS RaB DETERMINATION AT A MOUNTAIN AND A VALLEY STATION. R. Reiter (Univ., Munich, Germany). Naturwissenschaften, 47: 512(Nov. 1960). (In German)

Measurements of RaB concentrations in air, carried out since the end of 1958 simultaneously at a mountain station (Wank 1780 m NN) and at a valley station (Farchant 675 m NN) with stationary filters, permit a determination of the

half-value height of RaB. From the measurements the vertical difference between the two stations, the decay constants, the air density, and the vertical exchange coefficient and its dependence on the vertical temperature gradient and on the time of year or day can be calculated. The exchange coefficient of the vertical concentration drop of RaB for day and night is tabulated as a function of the temperature gradient. (J.S.R.)

9216 MEASUREMENTS OF THE RADIOACTIVITY OF ROCKS IN NORWAY. Thor Siggerud. Norg. Geol. Undersökelse, No. 211: 105-9(1959). (In Norwegian)

As part of the program for uranium prospecting, the radioactivity was registered along 20,000 km of roads in Norway. Only the more energetic γ activity was measured but a relationship between this and the total radioactivity was assumed. The radioactivity in ten localities is given as examples, showing a difference of 1 to 67 between the lowest and the highest radioactivity of the rocks in smaller areas. In larger areas a relation of 1 to 8 can be shown. Another result that was obtained, is that in a heterogenic geological complex, for example in gneisses, it is impossible to obtain good values for the average content of radioactive isotopes by only setting up instruments in a few points, or by radiometrical analyses of a few samples collected at random in the field. The measurements showed a great difference in the radioactive doses which the Norwegian population is exposed to, depending on the local geology. (auth)

9217 RADIOACTIVITY IN UNDERGROUND STOREROOMS AND FACTORIES. Thor Siggerud. Norg. Geol. Undersökelse, No. 211: 111-18(1959). (In Norwegian)

Several underground storerooms and factories were built in bedrock. The possible increase in radioactivity in such constructions is discussed. Concrete shielding should keep out most of the radioactivity from the bedrock, but radon could be a problem if the construction is not sufficiently ventilated. Measurements were of the γ radioactivity in 5 different underground constructions. The results are in accordance with the theoretical considerations, showing that in underground constructions in bedrock the radioactivity represents no problem. (auth)

9218 THE PEGMATITE DYKE AT RØMTELAND. A DESCRIPTION OF THE MINERALS AND A DISCUSSION OF THE MINERAL PARAGENESIS, ESPECIALLY WITHIN THE SYSTEM (Fe, Mn)O–TiO_2–Y_2O_3–(Nb, Ta)$_2O_5$–SiO_2. Thor L. Sverdrup. Norg. Geol. Undersökelse, No. 211: 124-96(1959). (In English)

The pegmatite dyke at Rømteland was subjected to a mineralogic-petrographic investigation based on field observations, chemical, x-ray, and microscopic studies from which the formation of the pegmatite and the mineral paragenesis were determined. Descriptions are given of the following minerals found in the pegmatite: microcline, allanite, alvite, apatite, bastnaesite, beryl, biotite, calcite, chalcopyrite, malachite, chlorite, columbite, epidote, euxenite, fluorite, hematite, hornblende, ilmenite, magnetite, malacon, molybdenite, muscovite, orangite, palygorskite, plagioclase, pyrite, quartz, samarskite, spessartite, sphene, anatas, tengerite, thorite, uraninite, clarkeite, fluormarierite, kassolite, α-uranophane, and zircon. (M.C.G.)

9219 NEUTRON ACTIVATION APPLIED TO GEOCHEMISTRY. W. Herr (Max-Planck-Institut für Chemie, Mainz and Universität, Cologne). Pure and Appl. Chem., 1: No. 1, 35-52(1960). (In English)

In recent years it has been established that radioactivation analysis is a very effective means of studying the fundamental problems of geochemistry and cosmochemistry. Recent work in the field and the remarkable possibilities the method offers are described. One of the great advantages of radioactivation analysis is that it permits simultaneously the quantity and isotopic composition of elements present in trace quantities. Special attention has been given to new techniques for gases and volatile materials. Research on the distribution and abundance of trace elements, especially problems in determining the geological age of ores and minerals, is of increasing interest. Measurement of the K/Ar ratio gives excellent results when it is based on the induced radioactivity of Ar^{41} and Ar^{37}. One can also apply neutron activation to the classical methods of determination of Rb/Sr and U/Pb. Useful data on the natural radioactivities of elements such as Lu^{176} and Re^{187} and on their possibilities of use in geological problems can be collected. In meteorite research, neutron activation serves also as an analytical method. Elements of interest are present in concentrations of 10^{-7} to 10^{-10} g/g. Thus stable spallation products, such as He^3, Li^6, K, Sc^{45}, formed by cosmic rays can be detected. These analytical data lead to better knowledge of energy spectra and the constancy of cosmic radiation with time. From this the radiological age and the material age of meteorites can be deduced. (tr-auth)

9220 SODIUM-22 IN THE BREITSCHEID METEORITE. Else Vilcsek and H. Wänke (Max-Planck Inst. für Chemie, Mainz, Germany). Z. Naturforsch. 15a, 1004-07 (Nov. 1960). (In German)

Sodium-22 was successfully measured in a meteorite. The Breitscheid meteorite, which was used in the investigation, fell August 11, 1956. From the count rate found, 0.21 ± 0.04 pulse/min, a decay rate of 0.089 ± 0.015 decays/min g was calculated for the moment of fall. Because of its relatively short half life of 2.6 years, Na^{22} appears especially suited for the investigation of the fluctuation of the cosmic radiation intensity with respect to the sun-spot periods. From the measured count rate, a mean intensity of the cosmic radiation of $I_0 = 0.68$ particles/cm^2 sec steradian was found. This value considers particles with energies down to about 100 Mev. Na^{22} decays into Ne^{22}. Together with the concentration of Ne^{22}, a radiation age for this meteorite of about 30 million years was obtained from the decay rate of Na^{22}. (tr-auth)

9221 RADIATION AGES OF CHONDRITES. Johannes Geiss and Hans Oeschger (Univ., Bern, Switzerland) and Peter Singer (Minnesota. Univ., Minneapolis). Z. Naturforsch. 15a, 1016-17 (Nov 1960). (In English)

Radiation ages for four chondrites, in which the concentration of tritium and all the isotopes of helium, neon, and argon were determined, were calculated from the He^3/H^3 ratios and from the average concentration of uranium, thorium, and potassium. Two groups were distinguished on the basis of high and low He^4 and Ar/K ages. Those in the first group have radiation ages about 22 ± 2 million years, suggesting their creation by a single break-up process. Low-activity rare-gas ages are correlated with low He^3 concentrations. (J.S.R.)

9222 GEOLOGY AND ORE DEPOSITS OF THE KERN RIVER URANIUM AREA, CALIFORNIA. E. M. MacKevett, Jr. (Geological Survey, Washington, D. C.). Geological Survey Bulletin 1087-F. 1960. 57p., 6 ills.

A geological description is given of the Kern River uranium area, an area of ~30 sq miles in northeastern Kern County, Calif. Small uranium deposits are erratically distributed along fractures, most of them within the Isabella granodiorite of Miller. The principal ore mineral is

autunite, but minor amounts of sooty pitchblende, carnotite, and metazeunerite have been found. Common gangue minerals are scarce in most of the deposits, and wallrock alteration is weak or absent. Some of the possible causes of uranium deposition are discussed. Minor gold and tungsten deposits also occur in the area. (D.L.C.)

9223 RADIOLOGICAL HEALTH DATA QUARTERLY REPORT, JANUARY 1961. Volume II, No. 9. (Public Health Service, Washington, D. C.). 63p. (PB-161371-10). $1.00(OTS).

The Public Health Service Radiation Surveillance Network was established in 1956 in cooperation with the Atomic Energy Commission to provide a means of promptly determining increases in environmental radiation due to radioactive fall-out from nuclear weapons tests. Data are tabulated on the radioactivity in samples of air, precipitation, foods, milk, soil, surface waters, and human bone collected in the United States and at other selected sites throughout the world. In addition to measurements of gross β radioactivity, some samples were analyzed for Sr^{90}, Sr^{89}, I^{131}, Ba^{140}, Cs^{137}, Zr^{95}, Nb^{95}, Ru^{106}, Ce^{144}, and W^{185}. Data are included on environmental levels of radioactivity at Atomic Energy Commission installations. (C.H.)

HEALTH AND SAFETY

9224 (AE-45) MEASUREMENT OF RADIOACTIVITY IN THE HUMAN BODY. I. Ö. Andersson and I. Nilsson (Aktiebolaget Atomenergi, Stockholm). Dec. 1960. 33p.

A body counter with a steel room and a 4-in.-diameter by 4-in.-thick NaI scintillation counter has been in operation since February 1958. It is used to control the internal contamination in people working with radioactive materials. Measurements were made on the natural activity in the human body. In May 1959 the average Cs^{137}/potassium ratio in a group of Swedish males was 73 $\mu\mu$c per gram of body potassium and in June 1960 55 $\mu\mu$c per gram of body potassium. The cessation of the nuclear bomb tests has caused a decrease in the cesium level in people. This gives some information of how cesium is entering the biosphere. (auth)

9225 (AECL-802(p.89-93)) AUTOMATIC FILM-BADGE PROCESSING. L. C. Bancroft (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.).

In order to provide more reliable and efficient processing of radiation film badges, a new badge was designed and automatic handling equipment is being developed for the processing operations. The new badge is constructed of nylon and holds the film packet in a slot which passes completely through the badge. Two badges are required for each employee since one set is in use while the second set is being processed. Badges are used for two weeks before the film is changed. (M.C.G.)

9226 (ANL-6199) RADIOLOGICAL PHYSICS DIVISION SEMIANNUAL REPORT JANUARY THROUGH JUNE, 1960. J. E. Rose and L. D. Marinelli (Argonne National Lab., Ill.). August 1960. 150p. Contract W-31-109-eng-38.

Separate abstracts have been prepared for 19 sections of this report. (For preceding period see ANL-6104.) (C.H.)

9227 (CEA-1697) RECHERCHE D'UNE METHODE DE CONTROLE DE LA POLLUTION ATMOSPHERIQUE DANS UNE CELLULE TRAITANT LE POLONIUM. (Research of a Method for Controlling Atmospheric Pollution in a Plutonium Treatment Cell). E. Bouteiller (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). 1960. 18p.

Aerosols likely to contain Po^{210} are trapped by bubbling through an acid solution. The problem of determining the polonium concentration of the solution was solved by combining it with telluric acid. The reduction is carried out at pH 0, using a solution of stannous chloride. Factors influencing coprecipitation were studied: nature of the medium, pH, amounts of telluric acid and stannous chloride. The average yield for the precipitation is 93%. After precipitation the polonium is filtered on paper, and its activity is measured by means of a scintillation counter. The method makes it possible to measure $\frac{1}{20}$ of the maximum permissible dose with an accuracy of 20%. (auth)

9228 (CF-59-11-30) DECAY HEAT IN SHIPPING CONTAINERS. J. C. Suddath (Oak Ridge National Lab., Tenn.). Nov. 6, 1959. 6p.

A test employing a simulated SRE fuel element in the shipping carrier indicated that the maximum surface temperature of the actual SRE elements will not exceed 532°F when 10 of the most active elements are in the carrier. Using measured surface temperatures and heat fluxes, the air film coefficient was calculated to be 2.9 Btu/(hr)(sq ft)(°F). (auth)

9229 (CF-60-9-57) PLUTONIUM RELEASE INCIDENT AT OAK RIDGE NATIONAL LABORATORY. L. J. King and J. C. Bresee (Oak Ridge National Lab., Tenn.). Jan. 10, 1961. 13p.

Presented at the ANS Winter Meeting, San Francisco, California, December 12-14, 1960.

A nonnuclear explosion involving an evaporator occurred on November 20, 1959, in a shielded cell in the Radiochemical Processing Pilot Plant at Oak Ridge National Laboratory. Plutonium released from the processing cell contaminated areas in the pilot plant building and nearby streets and building surfaces. The explosion is considered the result of rapid reaction of nitrated organic compounds formed by the inadvertent nitration of about 14 liters of a proprietary decontaminating reagent. In cleanup the contamination was bonded to the nearby street and building surfaces with tar, paint, roofing compound, or masonry sealer, as appropriate to the surface. Decontamination of the interior of the pilot plant building, except the processing cells, was 95% complete on September 1, 1960. (auth)

9230 (DP-524) SUGGESTED RCG VALUES FOR RADIOIODINE ISOTOPES IN FOODS. J. Henry Horton (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Oct. 1960. 18p. Contract AT(07-2)-1.

Radioactivity concentration guides (RCG) are suggested for radioiodine isotopes in milk, eggs, fruits and vegetables, meat, white and sweet potatoes, flour and cereal, fats and oils, and sugar, syrup, and preserves. The anatomical, dietary, and physiological characteristics of 19 categories of people were used to calculate values for both chronic and acute exposure. The RCG values for all foods except fats and oils were established by the characteristics of children less than 6 years of age. Typical chronic exposure RCG values for I^{131} were milk 5.5×10^{-7} μc/ml, eggs 6×10^{-4} μc/egg, and fruits and vegetables 1.1×10^{-5} μc/g (dry weight). (auth)

9231 (DP-528) EVALUATION OF PLASTIC FILMS FOR PROTECTIVE SUITING. Albert E. Symoods, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Nov. 1960. 18p. Contract AT(07-2)-1.

A laminate of Saran and polyvinyl chloride film was found to be the best of several films tested for use in suiting for protection of personnel in atmospheres containing tritium. Candidate films were evaluated by measuring the permeability to, and the diffusion rates of, tritiated water vapor

and by measuring the retention and ease of removal of tritium activity. An improved cell for measuring the permeability of polymer films was developed as a means of evaluating the films. The cell utilizes the ionizing properties of the radiation from tritium to detect the concentration of tritiated water vapor diffusing through the test films. (auth)

9232 (DRCL-310) GROUND PENETRATION OF γ RADIATION INTO A HOLE IN A SIMULATED (Cs-137) FALLOUT FIELD. C. E. Clifford (Canada. Defence Research Chemical Labs., Ottawa). Oct. 1960. 10p. Project No. D-89-16-80-15.

The dose distributions in a cylindrical foxhole due to ground penetration of 0.66 Mev γ radiation from Cs^{137} sources near the lip of the hole were measured for a "ground" of concrete. Ninety per cent of the dose due to ground penetration came from contamination within 1 ft of the edge of the hole. Measurements were also made of the dose distributions produced by the lip penetration of a lucite "ground." It was found that the dose produced by a single source under conditions of lip geometry could be calculated with reasonable accuracy by using one-half the infinite medium buildup factor for lip penetration distances of less than 8 mean free paths. (auth)

9233 (HW-62724) SHIELDING EFFICIENCY OF HEAVY ELEMENT NEOPRENE GLOVES AT LOW X-RAY ENERGIES. T. C. Mehas (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 23, 1959. 10p. Contract AT(45-1)-1350.

A heavily leaded glove, designated LLN-50, exhibits the highest all around shielding efficiency; however, it has, in addition to cost, the decided disadvantage of excessive weight and consequent physical limitation for routine application. In special instances of high exposures and relatively short time requirements, the glove might well find application. The lightly leaded glove, LLN-30, offers the next highest shielding efficiency and, all factors considered, is recommended for most routine applications wherein shielding of low-energy x or γ radiation is desired. The zinc-coated glove exhibits less shielding quality but does find some application due to its higher chemical resistivity. Neoprene gloves, of course, find their greatest applicability as a physical rather than a radiation barrier. As a brief example of comparative merit: at 16 kev, assuming radiation intensity and total accumulated dose to be constant, LLN-30 provides 22 times the allowable exposure time as when no glove is utilized, 8 times the allowable time when neoprene gloves are used, 5 times the zinc-coated glove, and $\frac{1}{3}$ less than LLN-50. Selection of the materials studied was made from the practical stand-point that all are currently available in standard 30-in. hood glove styles. Representative swatches approximately 6-in. square, were cut from four such gloves and the tests were made utilizing these swatches in lieu of the entire glove. Results are tabulated. (auth)

9234 (KAPL-M-HP-7) HEALTH PHYSICS AND SAFETY QUARTERLY REPORT, OCTOBER–DECEMBER 1960. Robert J. Feinberg, comp. (Knolls Atomic Power Lab., Schenectady, N. Y.). Contract W-31-109-Eng-52. 31p.

Routine radiation monitoring activities during the period are outlined. The quarterly and annual audits of external and internal radiation exposures revealed no personnel exposure greater than the applicable standards of the USAEC and the NCRP. Radioactivity levels in the environs of the Knolls Site indicated that laboratory operations did not contribute adversely to the radioactivity levels of the environment. (C.H.)

9235 (NP-9836) MODEL STUDIES OF BLAST EFFECTS. V. A COMPARISON OF AIR MOVEMENTS ASSOCIATED WITH THE ENTRY OF SHOCK WAVES INTO TRENCH TYPE SHELTERS OVER A SCALE RANGE OF 1/54 TO 1/5. Suffield Technical Paper No. 200. J. C. Muirhead (Canada. Suffield Experimental Station, Ralston, Alberta). Nov. 18, 1960. 25p. DRB Project No. D89-16-01-12.

The air movements associated with the entry of shock waves into 1/10 and 1/5 scale Simple trench models and a 1/10 scale Parapet trench model were studied. The results are compared with previous measurements of air movements in 1/54 and 1/27 scale Simple trench models and 1/10 scale Parapet trench models. The results showed that geometrical scaling of air movement exists over a scale range of 1/54 to 1/5, with a scale factor equal to the model ratio. (auth)

9236 (NP-9852) MAXIMUM PERMISSIBLE DOSES FROM EXTERNAL RADIATION. (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch. Radiological Protection Div., Harwell, Berks, England). Nov. 1960. 11p. (CODE-E.1.1.).

Maximum permissible doses of external radiation applicable to the operations of the United Kingdom Atomic Energy Authority are specified. Maximum permissible doses are specified for radiation workers, nonradiation workers, and of the general public. It is postulated that all exposures to radiation must be kept as low as practicable and any unnecessary exposure must be avoided. All doses must be kept below the maximum permissible values defined in this Code. (C.H.)

9237 (ORNL-2989) PLUTONIUM RELEASE INCIDENT OF NOVEMBER 20, 1959. L. J. King and W. T. McCarley (Oak Ridge National Lab., Tenn.). Feb. 16, 1961. Contract W-7405-eng-26. 77p.

A nonnuclear explosion involving an evaporator occurred in a shielded cell in the Radiochemical Processing Pilot Plant at Oak Ridge National Laboratory on Nov. 20, 1959. Plutonium was released from the processing cell, probably as an aerosol of fine particles of plutonium oxide. It is probable that this evaporator system had accumulated ~1100 g of nitric acid-insoluble plutonium in the steam stripper packing; the explosion released an estimated 150 g inside Cell 6, with about 135 g in the evaporator subcell, and about 15 g in the larger main cell. No radioactive material was released from the ventilation stacks; no contamination of grounds and facilities occurred outside of a relatively small area of Oak Ridge National Laboratory immediately adjacent to the explosion. No one was injured by the explosion, and no one received more than 2% of a lifetime body burden of plutonium or an overexposure to sources of ionizing radiation either at the time of the incident or during subsequent cleanup operations. The explosion is considered to be the result of rapid reaction of nitrated organic compounds formed by the inadvertent nitration of about 14 liters of a proprietary decontaminating reagent. In cleanup the contamination was bonded to the nearby street and building surfaces with tar, paint, roofing compound, or masonry sealer, as appropriate to the surface. Decontamination of the interior of the pilot-plant building, except the processing cells, was 95% complete on Sept. 1, 1960. Decontamination of the processing cells was delayed 8 months until building modifications could be made to improve containment. Modifications to the pilot plant have been proposed which will preclude discharges into the laboratory area and its environment of concentrations or amounts of radioactive materials that

would be injurious to health or interfere with other laboratory programs. (auth)

9238 (SC-4513(RR) RANGE SAFETY CONSIDERATIONS OF THE DEACON-ARROW SOUNDING ROCKET. Charles T. Force (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 114p.

Range safety aspects of the Deacon-Arrow sounding rocket are investigated. The Hi-Lo configuration of the vehicle is described, and its performance and estimated dispersion are presented. (auth)

9239 (WAPD-TM-17(Rev.)) ZIRCONIUM, ZIRCALOY, AND HAFNIUM SAFE PRACTICE GUIDE FOR SHIPPING, STORING, HANDLING, PROCESSING, AND SCRAP DISPOSAL. W. W. Allison (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Dec. 1960. Contract AT-11-1-GEN-14. 34p.

This guide directs attention to the fire and explosion hazards associated with zirconium, its alloys, and hafnium and emphasizes the measures that should be employed to prevent the occurrence of such hazards. The recommendations and requirements presented are based on conclusions drawn from available reports or data and from actual experience acquired in working with these metals. (auth)

9240 (WT-1424) ISOLATION OF STRUCTURES FROM GROUND SHOCK. (Stanford Research Inst., Menlo Park, Calif.). Apr. 18, 1960. Project 3.5 of Operation PLUMBBOB. 42p.

Project 3.5 was an initial study of the benefit derived from a special backfill in isolating or protecting underground structures from the violent motions produced by explosions in their vicinity. For this experiment, two test structures and one comparison structure were used. Each test structure consisted of a reinforced-concrete pipe enclosing a steel cylinder separated from the pipe by rubber O rings. Outside the concrete pipe was a special frangible backfill (glass bottles) around the sides and bottom. The comparison structure consisted only of a concrete pipe with a solid concrete bottom. All three structures were placed below ground with their axes vertical, with their tops approximately 2 ft below ground level, and with a concrete slab 1 ft thick and 15 ft wide above each one. One test structure and the comparison structure were placed 750 ft from Ground Zero (300-psi predicted peak overpressure; 229-psi actual). The remaining test structure was placed 1050 ft from Ground Zero (100-psi predicted peak overpressure; 104-psi actual). The peak accelerations of these structures, produced by shear forces exerted against their sides, were reduced by the frangible backfill to values 26% or less than those that the structures would have experienced if they had made intimate contact with the soil. Thus a special backfill was shown to be effective in enhancing the protection afforded by an underground structure. It is recommended that the properties of special backfills be investigated further. (auth)

9241 (AEC-tr-4443) MAXIMUM PERMISSIBLE FLUX OF INTERMEDIATE ENERGY NEUTRONS AND THEIR MEASUREMENT. A. G. Istomina and I. B. Keirim-Markus. Translated by James N. P. Lawrence and Jerome E. Dummer (Los Alamos Scientific Lab.) from Atomnaya Energ., 8: 239-47(1960). 16p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 13959.

9242 (CEA-tr-A-788) PROTECTION CONTRE LES RAYONNEMENTS DANS LES INSTALLATIONS DE RÉACTEURS ET D'ACCÉLÉRATEURS AUX U.S.A., AINSI QU'AU COURS DES MANIPULATIONS ET DE L'ELIMINATION DES DÉCHETS RADIOACTIFS. (Protection Against Radiation at Reactor and Accelerator Installations in the U.S.A. as well as Progress on Handling and Disposing of Radioactive Waste). W. Eickhoff. Translated from Berufsgenossenschaft, 9: 352-6(1958). 21p.

A discussion is presented of radiation protection at nuclear plants and radioactive waste treatment sites in the USA. (T.R.H.)

9243 (JPRS-7551) ELECTROMAGNETIC FIELDS IN INDUSTRIAL PREMISES HARBORING EQUIPMENT FOR HIGH-FREQUENCY HEATING. E. (Ye.) L. Kulikovskaya and Yu. A. Osipov. Translated from Gigiena Truda i Professional. Zabolevaniya, 4: No. 6, 3-6(June 1960). 7p.

High-frequency heating, used in industry, causes the development of alternating electromagnetic induction fields in the industrial premises. Working under such conditions may cause deleterious effects upon the health of personnel. It was determined that the voltage of an induction field is determined by the degree and nature of shielding employed on the high-frequency elements. Results are reported from a survey which show that the shielding provided by the manufacturers for high-frequency heating installations in the Soviet Union is not satisfactory for lowering voltages of electromagnetic fields. Suggestions are included for providing additional shielding of high-frequency elements. (C.H.)

9244 ACTIVATED CARBON FILTERS CONTROL RADIOACTIVE VAPORS. T. T. Porembski. Air Conditioning, Heating, and Ventilating, 57: 97-8(Nov. 1960).

A newly designed activated carbon and stack system to handle radioactive iodine vapor is operated in conjunction with existing air cleaning facilities at the Radioactive Materials Lab. The new facility will permit immediate sectioning and chemical and corrosion testing of irradiated samples which otherwise could not be handled until the samples had sufficiently decayed and safe to handle. Proper operation of the ventilation system depends upon the following factors: (1) Assurance that all isolation boxes are sealed; (2) proper equipment operation; (3) proper air balancing; and (4) assurance that the isolation boxes are under a negative pressure. The activated carbon filters, 95% efficient, used 2 in a series, provide a concentration reduction factor of $100 \times 400 = 4 \times 10^4$. This system has been found very satisfactory for the containment of radioactive effluents. (auth)

9245 LIMITS FOR COLD, HEAT AND HUMIDITY IN UNDERGROUND SHELTERS. C. P. Yaglou. Arch. Environmental Health, 2: No. 2, 110-15(Feb. 1961).

In the light of information available, underground fall-out shelters can be designed to maintain acceptable thermal conditions in temperate or arctic regions for isolation periods of about 2 weeks, with little or no artificial heating or cooling, and with only minimal ventilation. Mechanical cooling of shelters is essential in desert regions and in many hot-humid areas of the south, where soil temperatures at shelter depths are of the order of 75 to 85°F, compared with 45 to 55°F in the Temperate Zone, and 10 to 30°F in subarctic or arctic areas. (auth)

9246 DETERMINATION OF THE EXPOSURE OF HEALTH PERSONNEL TO X-RAYS AND RADIUM BY FILM DOSIMETRY. M. Fleischhacker and K. F. Schulz (Inst. of Hygiene, Zagreb and Inst. for Medical Research, Zagreb). Arhiv hig. rada i toksikol., 10: 171-6(1959). (In Yugoslavian)

Five hundred and twenty-seven measurements were made of the weekly radiation exposure dose of 360 persons in the

Health Service (173 physicians and 187 technicians and auxiliary staff) exposed to x rays (318) and radium (42). The results obtained were analyzed with regard to occupation, kind of work, working conditions, and the injury frequency rate. It was found that a comparatively large number of the personnel examined was exposed to high radiation doses due to defective equipment, improper technical and personal protective devices, and unsafe work methods. The lesions observed in physicians were more local (skin injuries), whereas those in technicians and auxiliary staff were related to the whole body (hemopoietic organs). (auth)

9247 METHOD OF DETERMINING THE DOSE RECEIVED FROM INHALED DECAY PRODUCTS DERIVED FROM RADON. I. I. Gusarov and V. K. Lyapidevskiĭ. Atomnaya Energ. 10: 64-7(Jan. 1961). (In Russian)

The dosage from inhaled radon is determined by measuring the number of α particles emitted in the total decay of radon daughters per liter of air. A method is suggested for determining dosage by the number of α particles emitted from the filter from a continuously purified medium. (tr-auth)

9248 THE PURIFICATION OF AIR FROM RADIOACTIVE AEROSOLS. L. Lassen (Univ., Heidelberg, Germany). Atomwirtschaft, 5: 511-18(Nov. 1960). (In German)

The removal of radioactive aerosols from air and effluent gases requires filter plants having an especially high grade of separator because of the serious toxicity of often submicroscopic particles. Further requirements are that the flow resistance should be small, the life should be long, activity should be easily and safely removable, costs should be reasonable, and the filter dimensions should not be too large. At present these requirements are best satisfied by dry filters of a fibrous base. As examples, the solution of filter problems in well-known nuclear installations is described with extensive technical data. The usefulness of various separating mechanisms and commercially available precipitators for radioactive aerosols is considered in detail. (auth)

9249 MANIPULATION AND HANDLING OF RADIOACTIVE SUBSTANCES. J. Savouyaud. Bull. inform. sci. et tech. (Paris) No. 43, 24-31(Sept. 1960). (In French)

In the design of hot cells for the manipulation and handling of radioactive materials not only irradiation and contamination dangers must be considered, but the physical state of the material, the nature of the radiation emitted, the work to be done on the material, and the usable tools must also be taken into account. A brief survey is given of the design and construction of hot cells, and the studies being undertaken on hot cell design are indicated. The problems in the transfer of radioactive liquids are also briefly discussed. (J.S.R.)

9250 CONTROL OF ATMOSPHERIC CONTAMINATION IN LABORATORIES OR WORKSHOPS. E. Mestre. Bull. inform. sci. et tech. (Paris) No. 43, 32-43(Sept. 1960). (In French)

The inhalation of radioactive substances, either gases or aerosols, is a risk incurred by all workers in hot laboratories. The means employed by the C.E.A. to control the atmosphere to prevent radiocontamination are briefly described. The utility of such a control for the determination of the restrictions to be applied for personnel protection is shown. The apparatus used for the control of both aerosols and gases is discussed. (J.S.R.)

9251 DANGERS FROM MINERAL DUSTS IN URANIUM MINES. J. Pradel. Bull. inform. sci. et tech. (Paris) No. 43, 44-51(Sept. 1960). (In French)

In the exploitation of uranium mines, one of the principal dangers comes from the inhalation of mineral dusts. The systematic control of the radioactivity from mineral particles in the air is described. The maximum permissible concentration is defined, and the principles of the measurement of the atmospheric activity are reviewed. Sampling apparatus are described. The results of a year's testing of the control procedure are presented. A comparison is then made between the risks from radon and from mineral dusts. (J.S.R.)

9252 DOSIMETRY OF TRITIUM IN THE ATMOSPHERE. A. M. Chapuis and G. Soudain. Bull. inform. sci. et tech. (Paris) No. 43, 52-7(Sept. 1960). (In French)

An apparatus for the batch measurement of atmospheric H^3 was designed and constructed. It consists essentially of two cylindrical chambers placed in parallel. The measurement chamber is coated with Hostaflon as insulator. The difference in the ionization currents of the two chambers is measured with a vibrating condenser electrometer. The calibration curve of the device is shown. The humidity and the radioactive component of the air appear to have no effect on the measurements. The modification of the device for continuous measurement is described, and the operation and calibration of the continuous measurement apparatus is discussed. (J.S.R.)

9253 THE NEW RECOMMENDATIONS OF THE INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION AND THE IMPORTANCE FOR RADIOLOGICAL PRACTICE. A. Rakow (Institut für Medizin und Biologie, Deutsche Akademie der Wissenschaften, Berlin). Deut. Gesundheitsw., 15: 192-9(1960). (In German)

A discussion is presented on the radiological protection standards and rules recommended by the ICRP in 1958. A brief historical review is included. The importance of the recommendations in medical radiology is the basis of the discussion. (T.R.H.)

9254 INTERNAL RADIATION DOSE MEASUREMENTS IN LIVE EXPERIMENTAL ANIMALS. [PART] I. R. L. Hayes, M. M. Nold, C. L. Comar, and H. Kakehi (Oak Ridge Inst. of Nuclear Studies, Tenn.). Health Phys., 4: 79-85 (Dec. 1960).

A study was made of the use of Schulman-Etzel small-volume dosimeters in the measurement of tissue dose in live animals administered pure β-emitting radioisotopes. The possible extension of this method to similar measurements with mixed β-γ and pure γ-emitters is discussed. The technique developed for the measurement of dose to the intestinal mucosa of animals given oral doses of pure β-emitters is described. The technique involves surgical implantation of dosimeters in the walls of the intestinal tract followed by recovery of the dosimeters after dosing. The application of certain correction factors to the measured response of the recovered dosimeters makes it possible to calculate the dose received by the surface of the intestinal mucosa. (auth)

9255 INTERNAL RADIATION DOSE MEASUREMENTS IN LIVE EXPERIMENTAL ANIMALS. [PART] II. M. M. Nold, R. L. Hayes, and C. L. Comar (Oak Ridge Inst. of Nuclear Studies, Tenn.). Health Phys., 4: 86-100(Dec. 1960).

Silver phosphate glass dosimeter rods were implanted in various portions of the digestive tract and the radiation dose was measured after ingestion of a known amount of Y^{90}. It was found that a state of diarrhea reduced the average radiation dose by a factor of from 2 to 4. In the constipated animal the dose was increased by a factor of from 3 to 7. Investigation was made to determine the role of various

processes governing the radiation dose delivered to gastrointestinal mucosa. The total dose to a particular site along the intestinal tract was obtained by determination of the time integral of the radioactive concentration. Serial sacrifices were made at specific times after administration of the radioactivity. Calculations in this manner agreed exceptionally well with the doses that were measured by the glass dosimeter method. It is estimated that 4 and 17 μc of Y^{90} for the dog and goat, respectively, will deliver a 300-mrad dose to the critical organ, the lower large intestine. The twelve-fold average difference in dose between the diarrhea and constipation groups of dogs emphasizes the importance of the physical state of bowel passages upon the dose delivered to the critical organ. (auth)

9256 SHIELDING CALCULATIONS FOR CIVIL DEFENSE. C. Eisenhauer (National Bureau of Standards, Washington, D. C.). Health Phys., 4: 129-32(Dec. 1960).

How the γ-ray penetration theory developed at the National Bureau of Standards has been applied to fall-out shielding problems is discussed. The concepts of barrier shielding and geometry shielding are discussed, and some comparison with experiment is given. The proposed publication of results is also described. (auth)

9257 THE RADIATION HAZARD FROM CONTAMINATED AIRCRAFT. J. Lawrence Kulp and J. L. Dick (Lamont Geological Observatory, Palisades, N. Y.). Health Phys., 4: 133-56(Dec. 1960).

A study of the relative importance of the external, inhalation, and ingestion hazards associated with surface contamination of aircraft that have penetrated atomic clouds or the stratosphere is described. Experiments were conducted at Operations Redwing and Plumbbob. They included γ- and β-γ-aircraft surveys, air sampling, swipe sampling, radiochemical and biological analyses, and personnel dosimetry. The latest maximum permissible total radiation dose limits and the NCRP total organ burdens are interpreted in terms of the aircraft maintenance problem. Curves are drawn to show the maximum permissible concentration of mixed fission products in air as a function of age of the debris assuming a 40-hr work week for both controlled and uncontrolled situations. Similar curves are given for the ingestion hazard. The radiological hazard from external radiation is compared with that presented by inhalation and ingestion. It is found for mixed fission debris on aircraft ranging in age from 1 hr to 1 year that the external radiation hazard is dominant by large factors under all normal working conditions. It is concluded that γ-surveying is generally adequate to define the radiation problem. Release to uncontrolled areas appears warranted if the average measured γ-field in potential working areas around the aircraft or its parts is less than 0.5 mr/hr regardless of age. Swipe sampling cannot be used to evaluate the local air concentration and thus the inhalation hazard. For mixed fission products on aircraft surfaces swipe sampling is no more reliable than the close β-survey of the surface for estimating the potential ingestion hazard. (auth)

9258 IMPROVEMENTS IN PERSONNEL-METERING PROCEDURES AT THE NATIONAL REACTOR TESTING STATION. F. V. Cipperley (U. S. Atomic Energy Commission, Idaho Falls, Idaho). Health Phys., 4: 173-8(Dec. 1960).

The construction and characteristics of film badges used at NRTS are described. Five types of film for use in the badges were investigated using radium γ's and uranium β's. Calibration curves are given. Methods for correcting the nonlinear response characteristics of film detectors are discussed. Procedures are described for automatically reading the film and recording the results on punched cards. The data recording techniques also provide for monthly and annual exposure experience reports. (D.E.B.)

9259 THEORETICAL AND PRACTICAL ASPECTS OF RADIATION HAZARDS. E. H. Belcher. Ing. nucleare, 3: 164-9(July-Aug. 1960). (In Italian)

After a brief outline of the recommendations on occupational exposure before 1958, the more recent recommendations are examined in greater detail. The various equipment used for personnel and area monitoring and for waste monitoring is described. Emphasis was laid on the influence that the diversity of the biological aspects of different radiations can have on the monitoring devices. (tr-auth)

9260 RAPID METHODS FOR ASCERTAINING WHETHER THE ACTIVITY OF A WEAK RADIOACTIVE SAMPLE EXCEEDS A PREDETERMINED LEVEL. E. H. Cooke-Yarborough and R. C. M. Barnes (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Brit. Nuclear Energy Conf., 6: 36-48(Jan. 1961). (AERE-R-3069).

Methods are considered for determining whether the mean rate of occurrence of random events, such as radioactive disintegrations, is greater or less than some given tolerance rate. The most efficient method is one which makes this determination in the shortest time and with an acceptably low probability of error. Sequential test procedures minimize the sample size by observing the random process until some terminating condition is satisfied. The performance of several sequential tests is investigated, with particular reference to conditions encountered in monitoring radioactive contamination on the hands. The most efficient of these tests is shown to be one which measures the difference between the number of events actually observed and the number expected at the tolerance rate. Under conditions likely to be encountered in routine monitoring for radioactivity on the hands this method gives a fivefold saving in time over the method now in use. (auth)

9261 ON THE SPRING MAXIMUM OF RADIOACTIVE FALLOUT FROM NUCLEAR TEST EXPLOSIONS. J. F. Bleichrodt, Joh. Blok, and R. H. Dekker (National Defence Research Organization TNO Rijswijk, Z. H., Netherlands). J. Geophys. Research, 66: 135-41 (Jan. 1961).

Some results of measurements are presented pertaining to the maximum of fall-out which was observed during the spring of the last few years. Evidence is presented that the height of this maximum is chiefly determined by the amount of radioactive debris present in the temperate or polar lower stratosphere, whereas seasonal factors determine the time of appearance of the maximum. (auth)

9262 CONTAMINATION MEASUREMENTS (RADIATION PROTECTION AT REACTORS AND IN NUCLEAR ENGINEERING OPERATIONS). I. M. Oberhofer (Technische Hochschule, Munich, Germany). Kerntechnik, 2: 360-5(Nov. 1960). (In German)

A survey is given on the highest permissible contamination, with emphasis on the highest permissible surface contamination. Various methods for the detection of surface contamination, including the sponge test method, are then discussed. The upper limits for the establishment of surface contamination by the application of the usual contamination detection and measurement instruments and the determination of the degree of contamination are then considered. (tr-auth)

9263 STUDY OF THE RADIOACTIVITY IN AIR IN THE LOWER REGIONS OF THE ATMOSPHERE IN MEXICO CITY. Augusto Moreno Moreno (Instituto de Fisica, Univ.

Nacional Autonoma, Mexico). Rev. mex. fís., 9: 85-128 (1960). (In Spanish)

The radioactivity of the lowest layers of the atmosphere is studied by filter collection of the air-carried dust. Data are presented for Mexico City during the year 1959. From the autoradiography of the filters, the size distribution of the spots left by the active particles on the photographic plate is obtained. The slopes of the decay curves of some of the samples are also given. (auth)

9264 METHODS OF PREDICTING RADIATION DOSAGE IN SPACE FLIGHT. Angus F. Bond, Michael G. Del Duca, and Andrew D. Babinsky (Thompson Ramo Wooldridge Inc., Cleveland). Preprint No. 60-21. Presented at the 6th National Annual Meeting, American Astronautical Society, 18-21 January 1960, New York City, New York. New York, American Astronautical Society, 1960. 28p.

Suggested computational methods are presented for evaluation of protective techniques for space crews against radiation. Assumptions concerning the radiation field are made, and intensity representations are discussed. Possible computer techniques are then suggested for doses received in the equatorial plane and the inclined plane. Future navigational aids are also discussed, with particular reference to course selection for minimum dose. (T.R.H.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

9265 (AD-243361) RADIATION STERILIZATION OF CANNED FOODS. Report No. 6 (Final) for December 1, 1955–June 30, 1959. J. M. Heinen (Continental Can Co., Inc., Chicago). 21p. Contract QMR and D (Natick) Research Agreement No. 24.

Results are reported from an investigation of the effect of meat-curing salts and several widely separated irradiation levels on the survival, germination, and outgrowth of spores of Cl. botulinum. Six different formulations of ground ham, corresponding to six different cure compositions, were prepared and packed in 202 by 202 cans. The cans were inoculated with one million spores per can of a suspension representing equal quantities of each of 5 type A and 5 type B strains. Ten can lots were provided for each formulation-irradiation level variable. After irradiation the cans were incubated at 85°F for 2 years and observed for spoilage. Radiation levels of 0.465 and 0.93 megarad did not prevent spoilage and the development of toxicity in any formulation. No toxic swells were encountered following irradiation at 2.79 and 3.72 megarads, although two formulations each gave one swelled nontoxic sample at 3.72 megarad. No cultures could be isolated from these samples. Irradiation at 1.86 megarads resulted in toxic spoilage in one formulation and one sample of nontoxic spoilage in another formulation. The culture isolated from the nontoxic spoilage was a member of the genus Bacillus and apparently was a normal contaminant of the product. Since these results are based on only 10 can lots for each formulation-irradiation variable with a comparatively low challenge dose of spores of Cl. botulinum, it might be expected that larger sample lots or a higher level of spore inoculum would result in spoilage of other formulations at the 1.86-megarad radiation dose or even at the 2.79 level. These results do not appear very favorable to the hope that the presence of meat-curing salts might permit the radiation sterilization of ham at a dose level not causing undesirable organoleptic effects. (auth)

9266 (NP-9811) AN INTRODUCTION TO RADIOACTIVE ISOTOPES AND THEIR USE IN THE TEXTILE INDUSTRY. H. E. Knobil. Jan. 1961. 16p.

Text of talk to the Midlands Section of the Textile Institute, Nottingham, January 25, 1961.

Industrial concerns in Great Britain saved three and a half million pounds in one year by the use of radioisotope techniques. Applications used by the textile industry included the use of β gages in textile processing; radioactive static eliminators; tracer studies using radioactive phosphorus in the study of wool fibers during drafting; the control of padding processes by radioactive labeling; radioautographic methods using tritium for locating resin finish in textiles; the irradiation of nylon to reduce surface resistance; and the radiation sterilization of goat hair used in the manufacture of carpets for the elimination of bacteria and control of possible anthrax. Atomic structure is reviewed briefly and precautions necessary in handling radioactive materials are discussed. (C.H.)

9267 (NYO-8726) INDUSTRIAL APPLICATIONS OF RADIOISOTOPES. Ralph L. Ely, Jr., Eli I. Goodman, Philip C. Reilley, Joseph A. Roll, and Robert F. Weise (Nuclear Science and Engineering Corp., Pittsburgh). June 15, 1959. 57p. Contract AT(30-1)-2203.

The progress achieved for each of four industrial applications development is reported. A portable, non-contacting liquid-level gage, useful for sealed tanks, was constructed. This gage uses a low-intensity γ source (15 μc Cs^{137}) and can measure liquid levels to $\pm\frac{1}{8}$ in. High counting efficiency γ counters operating as multicellular Geiger counters were constructed and tested. The counters consist of a stack of alternating anodes and cathodes in a halogen-quenched argon-neon counting gas. A study was performed to determine the feasibility of marking moving metal by electroplating a short-lived daughter from a solution containing its long-lived parent. The work performed has shown that a broader research and development effort is required to achieve a successful industrial application. Successful preparation of homogeneously tagged tool bits was achieved in the program to devise a tool wear measurement method using low levels of radioactivity. The radiological safety was demonstrated with bits whose specific activity was too low for routine measurement. In the course of this work, a β dip type detector was developed which has an efficiency of 4×10^5 cpm/μc-ml^{-1}. (auth)

9268 (SRIA-30) RADIATION PRESERVATION OF SELECTED FRUITS AND VEGETABLES. An Analysis of R&D Programing and Market Factors. (Stanford Research Inst., Menlo Park, Calif.). Jan. 1961. 234p. SRI Project No. IU-3267, Contract AT(04-3)-115.

Strawberries, peaches, citrus fruits, grapes, and tomatoes were irradiated experimentally. Results are inconclusive, but indications of both shelf-life extension and unfavorable radiation effects were observed at dose levels below 500,000 rads. These are promising commodities for radiation sterilization in terms of value, present shelf-life, incidence and amount of spoilage, and existing methods of preservation. The packing house is a logical location for the radiation source. Hourly capacities in the neighborhood of 10 tons per hour for the commercial facility are appropriate. Because of seasonal and geographical spread of harvesting, facilities adaptable to several crops and portable facilities deserve consideration. Preliminary results are presented from studies on the wholesomeness of irradiated foods, but more work will be required for grapes, strawberries, and tomatoes. The radiation levels and types of radiation used for pasteurization theoretically could cre-

ate extremely minute amounts of radioactivity. Technical knowledge is sufficient to permit engineering work on a source of γ radiation for pilot-plant operation. Surface irradiation technology, so far relatively undeveloped, could offer an alternative with the possibility of lower costs. Economic feasibility cannot be determined until later because cost estimates are preliminary and the potential benefits are not adequately known. (auth)

9269 (TID-3078 RADIOISOTOPES IN AGRICULTURE: ANIMAL HUSBANDRY, FERTILIZER UPTAKE, PLANT PHYSIOLOGY, PHOTOSYNTHESIS, AND ENTOMOLOGY, A Selected Bibliography. J. A. McCormick and Hugh E. Voress, comps. (Office of Technical Information, AEC). Dec. 1960. 39p.

This annotated bibliography contains 148 selected references on the uses of radioactive and stable isotopes in animal husbandry and in studies of fertilizer uptake by plants, plant physiology, photosynthesis, and entomology. These references were selected from scientific journals published during the period 1957 to 1958. Subject and author indexes and a list of the periodicals from which the references were selected are included. (auth)

9270 (TID-6959) RADIOISOTOPE AND RADIATION APPLICATIONS. QUARTERLY PROGRESS REPORT. Duane N. Sunderman (Battelle Memorial Inst., Columbus, Ohio). February 1, 1960. 39p. Contract No. W-7405-eng-92.

Four research programs are in progress concerning the application of radioisotopes to quality control, the application of intrinsic radioisotopes to industrial process control, the study of structural effects in radiation-induced graft polymerization, and the study of the effect of radiation upon the nitration of hydrocarbons. Experiments on activation analysis and radiometric techniques were conducted. Attempts to reduce activation analysis to quantitative techniques competitive with other instrumental techniques such as x-ray fluorescence have not been successful. Accuracy and reproducibility of the activation-analysis method have seldom been found better than ±10%. It is felt that these problems are inherent in the application of activation analysis to the determination of the constituents. Accuracies of the magnitude obtained in this program would have been quite suitable for the determination of trace elements. The determination of iron and aluminum in Portland cement and cement raw materials appears quite promising, although attempts to determine these by successive radiometric titration in the same solution have not been successful. Iron may be determined separately with high accuracy, and a method for the determination of aluminum based on a back-titration technique appears very promising. The application of intrinsic tracers to industrial process control is being evaluated experimentally for an iron-removal step in a nickel-refining process. The proportionality of the radioassay system has been demonstrated by successive addition of Fe^{59} tracer to the sensitive volume surrounding the detector. The effect of variations in temperature and composition of the process stream have been evaluated and appear negligible over the range of interest. Several attempts were made to utilize other radioactive materials as substitutes for Fe^{59}, but a suitable substitute has not been found. A study was begun on the mechanism of the formation of radiation-induced free radicals in methacrylate polymers. It was found that the electron paramagnetic resonance spectrum reported in the literature was due to residual monomer found in commercial methacrylates. An investigation of site formation with increasing dose disclosed that a different mechanism of free-radical decay may become prevalent at high dosages. A calculation of G_{site} for zero dose was obtained by extrapolation. The effects of temperature, ionizing-radiation dose, and phase of reactants upon nitroparaffin yield in the radiation-induced nitration of hydrocarbons have been evaluated experimentally. Results indicate that nitration is inhibited by the presence of ionizing radiation over most of the range of reaction times studied. Vapor-phase nitration also appears to give lower yields than the corresponding liquid-phase reaction. (auth)

9271 (TID-6960) RADIOISOTOPE AND RADIATION APPLICATIONS. QUARTERLY PROGRESS REPORT. Duane N. Sunderman (Battelle Memorial Inst., Columbus, Ohio). April 21, 1960. 45p. Contract No. W-7405-eng-92.

Four research programs which are in progress in the areas of radioisotope technology and radiation chemistry, are summarized. The emphasis in radiotracer quality control has been upon the development and evaluation of radiometric methods of analysis. Applications of this technique to the constituents of Portland cement have resulted in analytical methods for iron and sulfate which exhibit accuracy and precision equivalent to current ASTM methods. The iron procedure is based upon the complexometric titration of iron with EDTA, utilizing $Y_2^{91}(C_2O_4)_3$ as the endpoint indicator, while the sulfate procedure involves the precipitation of $Sr^{89}SO_4$ from a solution which is primarily organic with radioassay before and after precipitation indicating the amount of Sr^{89} required and, therefore, the amount of sulfate present. The evaluation of the feasibility of intrinsic tracers for process control involves technical, economic, and safety considerations. The technical aspects are under study for a representative system for the removal of iron in nonferrous minerals refining. Bench-scale studies indicate promise, and a process model is under construction to obtain data more of an engineering nature. The economics and safety considerations of intrinsic-tracer application are under study for a variety of hydrometallurgical process systems. Flow sheets are presented with descriptions of potential applications of this technique. The study of the effect of molecular structure upon radiation-induced graft polymerization is providing a wealth of basic information essential to greater industrial utilization of this technique. The production of active sites has been determined for a variety of substituted methacrylates as a function of radiation dose and substituent composition. The identification of the products of irradiation leads to an understanding of energy-transfer processes in polymeric systems which when sufficiently evaluated should point up techniques by which greater control of the physical and chemical properties of copolymers can be obtained. The radiation-induced nitration of hydrocarbons appears to offer no advantages over the thermally induced process in either vapor or liquid phases when either nitric acid or NO_2 is used as the nitrating agent. The nitration reaction occurs rapidly at temperatures either equal to or slightly above room temperature, and the presence of a field of ionizing radiation changes neither the spectrum nor the yield of the products obtained. The results of this study point up the desirability of research directed toward the utilization of ionizing radiation to induce reactions which are either not readily initiated at moderate temperatures or where the course of the reaction can be modified by changing the primary mechanism of energy input. (auth)

9272 (TID-6961) RADIOISOTOPE AND RADIATION APPLICATIONS. QUARTERLY PROGRESS REPORT. Duane N. Sunderman (Battelle Memorial Inst., Columbus, Ohio). July 25, 1960. 25p. Contract No. W-7405-eng-92.

Three programs are under way embracing the application of radioisotopes to quality control, the application of intrin-

sic radioactive tracers to industrial process control, and the study of structural effects in radiation-induced graft polymerization. A very brief review of the work conducted on the development of radioactive-tracer quality-control systems is presented. A topical report is in preparation which will describe in detail the application of radiometric techniques and activation analysis to quality control in the manufacture of portland cement. The emphasis in the study of the application of intrinsic radioactive tracers for process control was on the assembly of the process-model system. This assembly has been completed, and experimental work is under way. An outline of the experimental design is presented. The potential of intrinsic tracer control of the hydrometallurgical industry has been examined, and a variety of applications are suggested. The more basic study of intrinsic-tracer applications from the unit-operations standpoint will be presented in detail in a forthcoming topical report. It is anticipated that this study will provide the background necessary to an evaluation of the scope of applicability of the technique, whereas the hydrometallurgical study was concerned with the depth of potential application within an industry. The study of the effect of structural factors in radiation-induced graft polymerization has resulted in the development of a high degree of insight into the mechanism of active-site formation and the kinetics of the associated radiolysis. The application of advanced electron paramagnetic resonance, gas chromatographic, and infrared techniques has resulted in a phenomenological interpretation of the interaction of ionizing radiation and organic polymeric materials. Experimental results are presented and interpreted in terms of the basic energy-transfer mechanisms. (auth)

9273 (TID-6966) USE OF RADIOACTIVE TRACERS IN WATERFLOODING. QUARTERLY PROGRESS REPORT [Covering Period:] NOVEMBER 1, 1959 TO JANUARY 31, 1960. J. Wade Watkins (Bureau of Mines. Bartlesville Petroleum Research Center, Okla.). 5p. Contract AT(49-11)-1709.

Information on the migration through soil of radioactive ruthenium, probably as an anionic ruthenate complex, in the vicinity of radioactive-waste-storage facilities, suggests that ruthenium isotopes may be useful as tracers for following the subsurface migration of liquids. Extensive experience was gained in laboratory and field research on the use of radioactive tracers for following the horizontal and vertical travel of fluids injected to stimulate petroleum production. This research has revealed that, (1) to be useful as a water-tracer, a substance must have a low degree of loss through adsorption or ion exchange when in extended contact with solid reservoir-rock materials (2) In general, anions and complexes are subject to less loss than cations (3) H^3, as tritiated water, probably is the best general water tracer available because of its low loss, even though it is somewhat difficult to detect and (4) Any potential, untried tracer should be evaluated both in laboratory flow tests and in field tests under circumstances for which a basis of tracer-behavior comparison is available. Two tracer tests were started to obtain information on the performance of tritiated water as a tracer in a waterflooded petroleum reservoir, in which ruthenium and other radioactive ions also might be used. As it is desirable to test ruthenium and other tracers in rock formations where interconnected fracture systems are not present, the projects were selected on the basis of available data which indicate that injected liquids probably travel interstitially. The only method to determine this condition positively is by using tracers. Procedures are described. (auth)

9274 (TID-6967) USE OF RADIOACTIVE TRACERS IN WATERFLOODING. QUARTERLY PROGRESS REPORT [Covering Period:] FEBRUARY 1 TO APRIL 30, 1960. J. Wade Watkins (Bureau of Mines. Bartlesville Petroleum Research Center, Okla.). 6p. Contract AT(49-11)-1709.

Two field tracer tests using tritiated water as a comparison tracer are continuing. No tracer has appeared at the producing wells involved in the first test, nor is any expected for about 4 to 6 months. Tracer has appeared at two producing wells in the second of the two test locations at approximately the predicted time but at a considerably lower concentration than was expected. The reason for the low concentration is being investigated. Research on the complexing and stability of radioactive ruthenium isotopes was started. (auth)

9275 (TID-6968) USE OF RADIOACTIVE TRACERS IN WATERFLOODING. QUARTERLY PROGRESS REPORT [Covering Period:] MAY 1 TO JULY 31, 1960. J. Wade Watkins (Bureau of Mines, Bartlesville Petroleum Research Center, Okla.). 8p. Contract AT(49-11)-1709.

The two field tracer tests previously reported are being continued. Tracer has appeared in low concentration at a number of the production wells in one of these projects; none has appeared in the other. An investigation of the probable reason for the low concentration of the produced tracer was made and a reasonable answer obtained. A field survey is in progress to locate a producing waterflood property with much closer well spacing and less sand thickness. (auth)

9276 (TID-6970) USE OF RADIOACTIVE TRACERS IN WATERFLOODING. QUARTERLY PROGRESS REPORT [Covering Period:] AUGUST 1 TO SEPTEMBER 30, 1960. J. Wade Watkins (Bureau of Mines. Bartlesville Petroleum Research Center, Okla.). 6p. Contract AT(49-11)-1709.

Progress is reported in cooperative research on the use of radioactive tracers in waterflooding operations. Information on the migration through soil of radioactive ruthenium, probably as an anionic ruthenate complex, in the vicinity of radioactive waste storage facilities, suggests that ruthenium isotopes may be useful as tracers for following the subsurface migration of liquids. The primary purpose of this project is to determine the validity of this idea. The principal result of the tracer test conducted on the Merigale-Paul Unit No. 3 in Woods County, Texas, was to show the fallacy of attempting to estimate flooding efficiency from the analysis of production figures, water-oil ratios, and core data alone. Based on these data, the injected water apparently was bypassing through highly permeable zones or fractures. The results of the tracer test indicate that this is not true and that the flood water is passing more or less uniformly through the sand. The reason for the high water-oil ratio appears to be simply that the producing zone is watered out. A tracer material-balance study is in progress and may alter these conclusions somewhat. The test is being terminated, and analysis of the data obtained will be completed shortly. A water-tracer test with H^3-tagged brine is in progress at McCune, Kansas. The purpose of the test is to evaluate the property for use in the ruthenium tracer project. A pilot run was made of the production of sodium tetranitronitrosyl ruthenium(II). Preliminary tests of the product indicate the possibility of the presence of a second anionic compound. (auth)

9277 (TID-6971) INVESTIGATION OF RADIOISOTOPIC TRACER TECHNIQUES TO DETECT AND MEASURE DETERGENT RESIDUES ON WASHED FOOD PROD-

UCTS AND TO EVALUATE COMMERCIAL FOOD WASHING PRACTICES. Progress Report for period: May 1, 1959–March 15, 1960. W. A. Mercer, L. W. Regier, W. W. Rose, and J. E. Chapman (National Canners Assn. Western Research Lab., Berkeley, Calif.). March 18, 1960. 18p. Contract No. AT(04-3)-296. Project Agreement No. 1.

Detergents and wetting agents are widely used in the washing of fruits, tomatoes, and vegetables when these foods are prepared for canning, freezing, or fresh consumption. Although the use of detergents in food washing produces desirable results, the possibility exists that a residue problem may be created. Various raw foods, including green beans, brussels sprouts, asparagus, and tomatoes were used in experiments designed to demonstrate the sensitivity of radioisotopic tracer techniques for detecting and measuring detergent residue on washed foods. Results are tabulated. A comparison was made of colorimetric methods and radioisotopic methods for measuring the removal of alkyl benzene sulfonate from detergent-washed green beans. (C.H.)

9278 (TID-6977) AN INVESTIGATION OF THE USE OF RADIOACTIVE ISOTOPES FOR DETERMINING THE SURFACE OF POWDERED MATERIALS BY SORPTION METHODS. Annual Technical Status Report No. 1, Project No. A-446-3 covering the period April 1, 1959 to March 1960. Margaret C. Kordecki and Miriam L. Barnes (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). April 20, 1960. 32p. Contract AT(38-1)-202, Task No. III, Contract Authorization No. 1A-59-34.

The determination of powder surface area by sorption of fatty acids from solutions is an established technique. However, it is not in general use because methods for quantitative analysis of fatty acids lack the desired speed, convenience, and accuracy. This investigation was undertaken to develop a technique for accurate surface area determinations, particularly for relatively low-surface materials, by radioassay of sorbed fatty acids labeled with C^{14}. Such a technique has been developed and consists of the following steps: (1) weigh approximately 1 g of oven-dried powder into a round-bottom flask with a stopcock above the ground-glass joint at the neck; (2) heat 6 hr at 110°C with a Glas-Col heating mantle while simultaneously degassing by vacuum pump; (3) close stopcock, cool sample, and above the stopcock attach a burette filled with radiostearic acid-benzene solution (7 to 8 g/liter; 0.1 to 0.2 mc/g (of acid); (4) measure 10 ml of solution into the flask, close stopcock, and shake vigorously; (5) let sample equilibrate in water bath 1 hr at 15°C, with occasional shaking; (6) decant the solution into a centrifuge tube, stopper, and centrifuge briefly; (7) decant to another tube, stopper, and let solution reach room temperature before plating; (8) pipette 0.1-ml aliquots of this solution and of original solution to chilled 25-mm watch glasses and place in a refrigerator for slow solvent evaporation; and (9) count plates with a thin end-window Geiger counter. To improve the accuracy of this method, an empirical correction for self-absorption (and other factors tending to distort the relation of observed counts to concentration of the plated solutions) is used. It consists of determining the solution concentration from a plot of concentration vs. counts obtained by counting plates of several different known concentrations having the same specific activity as the solution used in the surface area determination. The surface area is then calculated from the following equation: $S_w = [(\text{initial-final moles/ml} \times 10\ \text{ml} \times 6.023 \times 10^{23} \times 20.5 \times 10^{-20}\ \text{m}^2/\text{mole})/(\text{sample weight})]$. For powders with surface area at the extremes of the range for which this method is applicable (0.1 to approximately 100 m^2/g), the conditions used in these determinations must be modified by, for example, larger sample weights and lower stearic acid concentrations for low surface areas, and small sample weights with high stearic acid concentrations for the larger surface areas. (auth)

9279 (TID-11610) A LITERATURE SURVEY ON THE EFFECTS OF IONIZING RADIATIONS ON SEA FOODS WITH RESPECT TO WHOLESOMENESS ASPECTS. Report No. 9656. S. A. Miller, J. J. Licciardello, J. T. R. Nickerson, and S. A. Goldblith (Massachusetts Inst. of Tech., Cambridge). [1958?]. 38p. Contract AT(30-1)-2580.

The aspects of the radiation preservation of marine products that are concerned with wholesomeness are discussed. In the first section the changes that take place in the microbiological flora on sea food following treatment with ionizing radiations are discussed. In the second section radiation-induced changes that take place in the organoleptic qualities of irradiated marine products are discussed. In the third and last part of this report the wholesomeness of irradiated sea food in terms of changes in nutrients and the possible production of toxic factors are discussed. Pertinent data appearing in both the published literature and reports submitted to a variety of governmental agencies are discussed. In addition, these studies were evaluated in terms of both the quality of the work and their usefulness in answering the problems associated with radiation-preservation. Suggestions are included for future research programs on the problems of the radiation-preservation of sea food. An appendix provides information concerning the various studies and projects that have been or are at present being conducted in this field. (auth)

9280 (AEC-tr-4266) A NUCLEAR GENERATOR FOR X-RAYS FOR FLUORESCENT SPECTRAL ANALYSIS. K. I. Narbutt, R. L. Barinskiĭ, and I. S. Smirnova. Translated by the U. S. Joint Publications Research Service, New York from Izvest, Akad, Nauk S.S.S.R., Ser. Fiz., 24: 354-61 (1960). November 1960. 11p.

The possible replacement of x-ray tubes with radiation sources is considered. An apparatus is described for doing fluorescent spectral analysis. It features a well-collimated and filtered source of Tm^{170}, scintillation detector, cathode follower, amplifier, differential amplitude analyzer, and scaler circuit. (W.D.M.)

9281 GAMMA-IRRADIATION OF VACUUM-PACKED SLICED MEAT PRODUCTS. Olle Dahl. Acta Polytech. Scand. Chem. Met. Ser., No. 9, 1-22(1960).

Vacuum-packed sliced bacon, cooked ham, cooked cured beef, smoked cured horse meat, thick bologna, and liver paste were γ irradiated with doses of 0.1, 0.2, 0.5, 1.0, and 2.0 megarad and stored at 22 to 28°C. At a dose level between 0.2 and 0.5 megarad, off-flavor appeared in all items. Change of color was observed after about one week's storage. Doses of 1.0 and 2.0 megarad made the products turn brittle, evidently due to nonenzymatic destruction of the tissue. A dosage of 2.0 megarad was sufficient to achieve practical sterility in all products under the conditions used. Long-term storage was limited owing to oxidative rancidity and destruction of texture. (auth)

9282 TRANSFORMATION OF THE ENERGY OF SHORT-LIVED ISOTOPES. M. G. Mitel'man, R. S. Erofeev, and N. D. Rozenblyum. Atomnaya Energ. 10: 72-3(Jan. 1961). (In Russian)

Experiments were made with a transformer consisting

of a Rh^{103} emitter and collector separated by a solid dielectric or a vacuum. Neutron interactions with rhodium produced Rh^{104}, a 2.5-Mev β emitter with a 41.8-sec half life. When placed in a neutron flux of 10^{12} neutrons/cm^2/sec, the transformer produced a current of 4.2×10^{-8} amp and 420 v with an external resistance of 10^{10} ohm. The number of β particles emitted was 6×10^{-8} amp. The reduced current is due to β absorption in the emitter and dielectric. In a reactor with a neutron flux of 10^{10} to 10^{11} neutrons/cm^2/sec, the current fell to 1.6×10^{-9} amp within 2 min, in good agreement with theoretical postulation. The transformer is capable of producing constant high-voltage and may also be used to measure neutron flux and determine reactor capacity. (R.V.J.)

9283 RADIOACTIVE ISOTOPES IN THE PETROLEUM INDUSTRY. S. Stemerding (Shell Laboratorium, Amsterdam, Netherlands). Atoomenergie, 2: 191-8(Dec. 1960). (In Dutch)

Radioisotopes are used in two ways in the oil industry; as radiation sources or as tracers. Examples of both utilizations are given, but special emphasis is placed on tracer techniques. (tr-auth)

9284 RADIOGRAPHY WITH RECOIL ATOMS. Čestmír Jech (Inst. of Physical Chemistry, Czechoslovak Academy of Sciences, Prague). Československ. časopis pro fysiku, 10: 294-6(1960). (In Czech.)

A description is given of the technique of radiography using recoil atoms, and the method of preparing a source of recoil atoms suitable for this purpose is discussed. (auth)

9285 DATA FOR INDUSTRIAL IRRADIATOR DESIGN FROM AN EXPERIMENT TO REDUCED SCALE. D. B. Dove, J. P. A. Ridout, and G. S. Murray (Wantage Radiation Lab., Berks, Eng.). Intern. J. Appl. Radiation and Isotopes, 9: 27-33(Dec. 1960).

Design data for industrial irradiation units may be obtained from measurements with a model to reduced scale. Validity and applicability of the method are discussed, and relations are given between absorbed dose rate distributions within the model and full scale unit. The results of a reduced scale experiment are applied to a determination of irradiator efficiency and prediction of throughput in a full-scale unit containing a source of 150,000 c Co^{60}. Dose rate distributions are examined within packages of various size. (auth)

9286 A METHOD OF LEAK TESTING HERMETICALLY SEALED COMPONENTS UTILIZING RADIOACTIVE GAS. B. Cassen and D. Burnham (American Electronics, Inc., Culver City, Calif.). Intern. J. Appl. Radiation and Isotopes, 9: 54-9(Dec. 1960). (In English)

A method of leak testing hermetically sealed components such as transistors, relays, frequency standard crystals, small munitions, etc., utilizing a chemically inert radioactive gas (Kr^{85}) is described. A leak rate formula based on Poiseuille's law is developed and the limitations in measurement imposed by the range of validity of this formula and of the random nature of radioactive decay are discussed. Means for differentiating between radioactive gas which has leaked inside the part being tested and gas absorbed on its surface are presented. A logarithmic rate unit called the leak index is proposed. A brief description of industrial equipment for accomplishing leak rate measurements along with precautions to assure full safety in its operation is given. (auth)

9287 TRANSPORTABLE LEVEL CONTROL USING RADIOACTIVE RADIATION. V. Netz (VEB Vakutronik, Dresden, Germany). Isotopentechnik, 1: 20-2(Jan. 1960).

Stationary level control and measuring equipment have proved for many years their usefulness in industrial measurement and control engineering. Problems of measuring equipment, measurement process, and radiation source in a portable level control instrument are discussed. Some special applications are considered. (auth)

9288 K^{40} GAMMAS GIVE ESTIMATE OF LEAN MEAT CONTENT. Derek H. Pringle (Nuclear Enterprises, Ltd., Edinburgh) and Roman Kulwich. Nucleonics, 19: No. 2, 74; 76; 78(Feb. 1961).

For use in measuring the lean content of meat, a large number of K^{40} activity measurements are being made. A large 4π scintillation counter which can handle 80-lb samples is described as being used in the study. It can separate the fall-out Cs^{137} 0.661-Mev activity from the natural K^{40} 1.46-Mev gamma. The Cs^{137} data are also important for public health studies. It is evident from a few observations that there is a nearly linear relation between K^{40} count and lean content in 50 to 60-lb ham samples. (T.R.H.)

9289 INDUSTRIAL APPLICATIONS OF RADIOACTIVATION ANALYSIS. P. Leveque (Centre d'Etudes Nucleaires, Saclay, France). Pure and Appl. Chem., 1: No. 1, 53-60(1960). (In French)

A main feature of activation analysis is its extreme sensitivity. Hence it has been principally employed for trace detection and its most extensive use has been in the control of semi-conductors and very pure metals. The need to activate the samples in an atomic reactor has, however, hindered its systematic utilization. The errors inherent in radioactivity measurements make it little suited for determining the main constituents of a sample. On the other hand, the utilization of radiation-matter interactions seems to open the way to a whole series of nondestructive and rapid analyses which are worthy of note, although they are not, strictly speaking, activation analyses. (auth)

ISOTOPE SEPARATION

9290 (TID-11621) THE SEPARATION OF ISOTOPES AND ORTHO-PARA HYDROGEN AND DEUTERIUM BY PREFERENTIAL ADSORPTION AT LOW TEMPERATURE. THE THERMODYNAMIC PROPERTIES OF ORTHO-HYDROGEN AND PARA DEUTERIUM. Technical Progress Report for Period December 1, 1959–November 30, 1960. David White (Ohio State Univ. Research Foundation, Columbus). Dec. 1960. 102p. Project No. 761. Contract AT(11-1)-522.

Experiments indicated that the isotope separation factor for deuterium and hydrogen by preferential adsorption is ~40 to 50 at 20°K. Ortho-para separation by desorption at 20°K using γ-alumina gave values of 3 to 3.6 for deuterium and values of 6 to 9 for hydrogen. The differential heat of adsorption of hydrogen on alumina is estimated at ~1.75 kcal. The differential heat of adsorption difference for deuterium and hydrogen is ~150 cal in the limit of zero surface coverage. The modifications to the theory necessary to explain the results are described. Experiments on the heat capacity of adsorbed hydrogen on alumina for various surface coverages were undertaken to determine the validity of the mobile layer assumption and the nature and magnitude of the adsorbed layer excitations. The theoretical investigation of the separation of heteronuclear diatomic isotopic hydrogen by preferential adsorption was continued. A summary is appended of the differential equations solved for a variety of parameters. The separation of the nuclear spin isomers of methane by preferential adsorption was investigated from methane condensed on an alumina surface

containing paramagnetic material to promote conversion and from methane condensed as a pure solid. An examination of the rotational spectra of the methane samples revealed smaller differences than were predicted by the calculations. The heat capacity of solid deuterium was measured for various para concentrations. (B.O.G.)

9291 (AEC-tr-4406) HIGH-SPEED GAS CENTRIFUGE. Translated for Oak Ridge Gaseous Diffusion Plant from German Patent No. 1,071,593. Dec. 17, 1959. 14p.

A description of a high-speed gas centrifuge for separation of gas mixtures, particularly isotopes, is presented. The centrifuge has a rotor, which is closed at the bottom, rotating around a perpendicular shaft and is contained in a fixed housing under reduced pressure. The rotor is provided with a circular top opening through which supply and removal pipes pass. (J.R.D.)

9292 (GAT-Z-5016) GERMAN PROCEDURES FOR THE ENRICHMENT OF THE URANIUM ISOTOPE. W. Groth. Translated by J. R. Arndt from Chem. Ingr. Tech., 31: No. 5, 310-18(1959). 15p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 7670.

9293 PHYSICAL PROPERTIES OF ISOTOPIC FORMS OF SOME INORGANIC ACID-WATER AZEOTROPES. Karl Erik Holmberg (AB Atomenergi, Stockholm, Sweden). Acta Chem. Scand., 14: 1660-6(1960). (In English)

The azeotropes of DCl, DBr, or DNO_3 with D_2O are more volatile than the corresponding azeotropes containing H. In the $HCl-H_2O$ and $HBr-H_2O$ azeotropes, the difference in volatility of O^{16} and O^{18} is larger than in water. Other isotope enrichment effects are small or imperceptible. Differences in other physical properties, such as density, viscosity, and refractive index, are similar to those between H_2O and D_2O though less pronounced. (auth)

9294 DATA ON THE SEPARATION OF THE ISOTOPES OF BORON BY MEANS OF VOLATILE COMPOUNDS. I. Kishsh, I. Opauski, and L. Matush (Central Scientific-Research Inst. of Physics, Laboratory of Nuclear Chemistry, Budapest, Hungary). Atomnaya Energ. 10: 73-5(Jan. 1961). (In Russian)

The efficiencies of various oxygen containing organic compounds for boron isotope enrichment were compared, and the changing character and volatility of isotopic boron compounds were analyzed. Experiments were made with anisole$-BF_3$, ethyl ether$-BF_3$, and acetic acid$-BF_3$ systems. The results for alkylborate and boron halide distillation indicate a distillate enrichment of the heavier isotope. It is suggested that boric acid-ether complexes can be efficiently utilized in boron isotope separation. (R.V.J.)

9295 A RESEARCH ON ISOTOPIC COMPOSITION OF EVOLVED HYDROGEN MOLECULES WITH SPECIAL REFERENCE TO THE MECHANISM OF NICKEL CATHODE. Kozo Hirota and Takeo Hisano (Osaka Univ., Japan). Bull. Chem. Soc. Japan, 33: 1019-20(July 1960). (In English)

An investigation was conducted of the isotopic composition of molecules evolved in the electrolysis of aqueous solutions. The electrolysis was carried out on 1N sodium carbonate solution with the cathode of nickel plate and the anode of platinum wire. Deuterium content in the original solution was 65.2 at.%. The ratio $H_2:HD:D_2$ of the hydrogen evolved at the cathode as well as the separation factor α, defined by $(H/D)_{gas}/(H/D)_{sol}$, were determined mass-spectrometrically. The results are summarized for 0°C electrolysis. It is shown that α increases with current density and approaches the value of 7.4. It is noted that the factor K (obs.) = $[HD]^2/[H_2][D_2]$ is 2.7 or 2.8 which is less than the K(equil.), i.e., 3.25 at 0°C. (B.O.G.)

9296 STUDIES OF THE LOW TEMPERATURE DISTILLATION OF HYDROGEN ISOTOPES. T. M. Flynn (National Bureau of Standards, Boulder, Colo.). Cryogenics, 1: 96-100(Sept. 1960).

Experimental data obtained from the operation of 1.35-in.-diameter distillation columns were used for the design of a pilot plant column. This column was constructed and operated to study the separation of hydrogen deuteride from hydrogen by fractional distillation. The pilot plant column contains thirty plates, 6 in. in diameter, made of 40 mesh screen and has a maximum feed rate of 14.2 ft^3(n.t.p.)/min. The column was operated with vapor velocities ranging from 0.2 to 2.0 in./sec and reflux ratios from total to an (L/D) of 2.05. Over-all plate efficiencies were investigated and found to vary, as a function of vapor velocity, from 45 to 55%. The over-all plate efficiencies of the pilot plant column are significantly lower than those of the smaller diameter columns. This difference in plate efficiency is examined theoretically. A model considering the effect of liquid mixing on the plate satisfactorily describes the change in efficiency and predicts that no further decrease in efficiency with increasing diameter will occur. (auth)

9297 SEPARATION OF HYDROGEN ISOTOPES BY DISTILLING AZEOTROPIC MIXTURES OF STRONG ACIDS IN WATER. I. THEORY OF THE SEPARATION METHOD. K. Wetzel (Inst. für Physikalische Stofftrennung, Leipzig, Germany). Isotopentechnik, 1: 15-18(Jan. 1960). (In German)

In the distribution of hydrogen isotopes among liquid, azeotropic acid–water mixtures, and their equilibrium vapors, chemical exchange equilibria are co-determinant. It is shown that the total separation factor $\alpha_{HX} = (D/H)_{vapor}/(D/H)_{liquid}$ in the range of small D concentrations can be expressed by the equilibria $(H_2DO)_{liquid} + (H_2O)_{liquid} \rightleftharpoons (H_3O)_{liquid} + (HDO)_{liquid}$; $(H_2DO)_{liquid} + (HX)_{liquid} \rightleftharpoons (H_2O)_{liquid} + (DX)_{liquid}$; $(HDO)_{vapor} + (H_2O)_{liquid} \rightleftharpoons (H_2O)_{vapor} + (HDO)_{liquid}$; $(DX)_{vapor} + (HX)_{liquid} \rightleftharpoons (HX)_{vapor} + (DX)_{liquid}$; and $(H_2O)_{liquid} + (HX)_{liquid} \rightleftharpoons (H_3O)_{liquid} + (X^-)_{liquid}$. If, as in the case of the azeotropic nitric acid–water mixture, the acid strongly dissociates and the mole ratio acid: water is of the order of magnitude of one, then the influence of the hydroxonium–water exchange with a separation factor of $\alpha_{HW} = 1.3 - 1.5$ (at normal temperature) is dominant. Thus distillation of azeotropic nitric acid represents a useful method of separating hydrogen isotopes. (auth)

9298 THE SEPARATION OF HYDROGEN, DEUTERIUM AND HYDROGEN DEUTERIDE MIXTURES BY GAS CHROMATOGRAPHY. Paul P. Hunt and Hilton A. Smith (Univ. of Tennessee, Knoxville). J. Phys. Chem., 65: 87-9 (Jan. 1961).

The resolution and analysis of the components of hydrogen–deuterium mixtures were accomplished by gas chromatography at 77°K. Neon was employed as the carrier gas, and the column was chromia deposited on alumina. Orthohydrogen and parahydrogen did not separate on the chromia–alumina column. The separation factor for hydrogen deuteride and deuterium was much greater than that for hydrogen and hydrogen deuteride. The complete separation of deuterium and hydrogen deuteride was also obtained on a silica gel column with hydrogen as the carrier gas, whereas a charcoal column produced very little separation. (auth)

9299 THE EXCHANGE OF DEUTERIUM GAS WITH THE HYDROGEN ASSOCIATED WITH SOLID CATALYSTS. II. KINETICS AND MECHANISM OF THE REACTION WITH

HYDROGENATED TANTALUM. W. Keith Hall, W. E. Wallace, and F. J. Cheselske (Mellon Inst., Pittsburgh). J. Phys. Chem., 65: 128-32(Jan. 1961).

The rate of the transport of hydrogen from solid tantalum hydride to gas was found to be proportional to pressure while the solubility of hydrogen in tantalum varies as the square root of pressure. These facts, together with the previously determined activation energy (14.9 ± 0.5 kcal/mole) and the absolute magnitude of the rate, can be satisfactorily rationalized if it is assumed that the rate-determining step involves desorption of hydrogen molecules from the surface. When deuterium is present, this corresponds to a Bonhoeffer–Farkas-type mechanism for the exchange reaction. A Rideal-type mechanism, involving an exchange between a molecule and an adsorbed atom, would appear to be ruled out on the grounds that the observed pressure dependence would require that the surface be nearly completely covered with adsorbed hydrogen atoms; evidence has been obtained indicating that this probably is not the case. (auth)

9300 GAS CHROMATOGRAPHY OF PARAHYDROGEN, ORTHOHYDROGEN, HYDROGEN DEUTERIDE AND DEUTERIUM. Shozo Furuyama (Hokkaido Univ., Sapporo) and Takao Kwan. J. Phys. Chem., 65: 190-1(Jan. 1961).

A method is presented for separating ortho-H_2, para-H_2, HD, and D_2 from each other and obtaining four separate peaks on a single chromatogram. In this method, two chromatographic columns are used in series; the first one is active alumina, while the second is active alumina coated with ferric oxide. The column temperature is –195°C, and helium is used as carrier gas. Four peaks result with 6 to 10 min retention times. Two experimental runs indicate that the analytic performance of the method is satisfactory. (D.L.C.)

9301 PRODUCTION OF VERY HIGH PURITY ISOTOPES BY A DOUBLE MAGNETIC DEFLECTION ISOTOPE SEPARATOR. R. Bernas, J. L. Sarrouy, and J. Camplan (Université, Paris). Rev. Sci. Instr., 32: 96-7(Jan. 1961).

An instrument is described for preparation of very pure isotope samples. It has two magnetic analyzers in cascade separated by a diaphragm which acts as a source for the second stage. The first stage is a 60° homogeneous magnetic sector with a mean radius of 50 cm. The second is a 180° inhomogeneous field of cylindrical symmetry such as $H_r = H_{r_0} (r_0/r)^n$ with n = 0.48 and r_0 = 400 mm. (T.R.H.)

9302 ISOTOPE SEPARATION BY LOW-TEMPERATURE EXCHANGE. THE $BF_3 \cdot SO_2$ SYSTEM FOR BORON-10 (1). Ryohei Nakane and Osamu Kurihara. Sci. Papers Inst. Phys. Chem. Research (Tokyo) 54: 274-80(Sept. 1960). (In English)

It was found that an addition of boron trifluoride to sulfur dioxide affords a liquid molecular complex at –95°C, but scarcely any complex above –89°C, by measuring the single-stage separation factor for isotopic exchange between BF_3 gas and BF_3 in SO_2 solution at low temperature. Its value varied from 1.028 at –95°C to 1.006 at –78°C, with B^{10} concentrating in the liquid phase. By utilizing this exchange reaction, a new gas-liquid countercurrent system was developed for the separation of boron isotopes. Ascending BF_3 gas passed countercurrent to descending BF_3 in the SO_2 solution in a glass column 50 cm long and 9 mm in diameter packed with 2 mm stainless steel Dixon's gauze rings. Reflux at one end was attained by heating and at the other end by cooling. Even at –78°C, B^{10} was 1.78 fold enriched at bottom, and thus, it is evident that an association-dissociation method can be employed for the $BF_3 \cdot SO_2$ system and that boron isotopes are effectively separated by this method, if the exchange is multiplied at –95°C. The major advantage of the $BF_3 \cdot SO_2$ system for boron isotope separation is that a separation factor at –95°C, is fairly high, being comparable to the $BF_3 \cdot$ anisole system. An association-dissociation method can be employed; the corrosion of construction materials or the decomposition of the compounds is very small in comparison with an organic complex system such as $BF_3 \cdot$ anisole system; and there is no need of the mechanical rotating apparatus except a freezer. (auth)

9303 A LOW-TEMPERATURE PLANT FOR THE PRODUCTION OF HEAVY WATER. Jost Hänny. Sulzer Tech. Rev. (Switz.), 42: No. 2, 9-24(1960). (In English)

A plant for the production of heavy water, which was erected by Sulzer Brothers for Emser Werke AG. at Domat/Ems, Switzerland, is described. The raw material is natural water which first undergoes seven-fold deuterium enrichment in three electrolysis stages. The gaseous mixture of hydrogen and deuterium produced by electrolytic dissociation is cooled to –251°C. The liquid then goes to a Kuhn rectifying column, where the exchange processes taking place at 22°K result in 400-fold deuterium enrichment. The product of the column is burned with oxygen and then passed to a second Kuhn column in which the D_2O concentration is brought up to 99.8%. The plant at Ems employs oil-free labyrinth-piston compressors and high-speed expansion turbines for hydrogen. High vacuum is used to insulate all heat exchangers, turbines, and control units. (auth)

9304 NEW METHOD OF SEPARATION OF BORON ISOTOPES. E. M. Kuznetsova, G. M. Panchenkov, R. S. Filippova, and V. F. Malakhov (Moscow State Univ., U.S.S.R.). Zhur. Fiz. Khim., 34: 2370-1(1960). (In Russian)

An attempt was made to extract boron using water and isoamyl alcohol. The isotopic analysis was made with a mass spectrometer. The tabulated data show that boron fractionation takes place between the boron isotopes: the light isotopes concentrate in the head-end fraction and the heavy in the tail-end one. Thus solvent extraction of boron is possible. However, combination of solvent extraction with complexing characteristics for boron would increase the efficiency and economy of the extraction. (R.V.J.)

9305 METHOD OF SEPARATING LITHIUM ISOTOPES. K. Peters. French Patent 1,187,675. Mar. 9, 1959.

Lithium isotopes are separated by fractional precipitation, starting with a solution of a complex lithium salt (e.g., lithium salt of alumino-oxalic, -tartaric, or -citric acid), the precipitation being performed with NH_4 carbonate or phosphate under strictly optimal conditions as regards temperature, pH, rate of addition of the precipitant, and rate of stirring. Just prior to the first signs of precipitation the solution may be inoculated with the relevant finely divided Li^7 compound. The Li^7/Li^6 ratio can be increased from 12.48 in the starting material to 26.80 to 34.71 in the first fraction. (NPO)

9306 DEVICE FOR IRRADIATING FLUIDS WITH FILTERED THERMAL RADIATION. (to Compagnie Française Thomson-Houston). French Patent 1,189,979. Mar. 31, 1959.

The device comprises a thermally insulated space in the interior of which an incandescent element and two coaxial tubes with walls that are transparent to the thermal radiation are parallelly mounted. The fluid to be irradiated is circulated through the inner tube while a second fluid which filters the radiation is circulated through the annular space

between the tube walls. The device can be applied for the separation of isotopes contained in molecules of different types. One of the types is thereby selectively excited to accelerate its transformation into another type, the isotope separation thus being reduced to a chemical or physical separation of very different molecules. (NPO)

9307 PROCESS AND EQUIPMENT FOR DECREASING THE DEUTERIUM CONCENTRATION IN THE LIQUID ADHERING TO A PULVERULENT CATALYST AFTER ITS FILTRATION FROM A SUSPENSION. (to Friedrich Uhde G.m.b.H.). French Patent 1,201,757. July 15, 1959.

In the catalytic isotope exchange between water and hydrogen, the catalyst is separated by filtration and recycled. Since the recycled catalyst should have the lowest possible deuterium content, the filter cake is alternately rinsed with water and swept with hot hydrogen. The rinse water and the sweep gas are introduced at the proper places of the exchange apparatus; the rinse water can also be utilized for the production of hydrogen. After the recycling of the catalyst, the filter compartment involved is likewise swept with hot gas. (NPO)

9308 ISOTOPE SEPARATOR. R. G. L. Gassot. French Patent 1,203,343. July 27, 1959.

A schematic isotope separator in which an electrolyte is simultaneously subjected to electrolysis and centrifugal forces, the different isotopes being collected on separate, adjustable cathodes is described. A cascade system is proposed in which a cathode of one stage forms the anode of the next stage. (NPO)

9309 PROCESS AND EQUIPMENT FOR THE SEPARATION OF TWO FLUIDS HAVING DIFFERENT DENSITIES, NOTABLY APPLICABLE TO THE SEPARATION OF ISOTOPES. (to Société Nationale d'Etude et de Construction de Moteurs d'Aviation). French Patent 1,203,883. Aug. 3, 1959.

An apparatus is described in which an adjustable gyratory movement is imparted to a mixture of fluids of different densities, the mixture having previously been greatly diluted with a third fluid of lower density, e.g., hydrogen or helium. Centrifugal forces cause a separation of the components in the whirlpool. Some theory underlying the separation method is given. (NPO)

9310 PROCESS AND APPARATUS FOR GAS AND VAPOUR, NOTABLY ISOTOPE SEPARATION. (to Deutsche Gold- und Silber-Scheideanstalt vormals Roessler). French Patent 1,205,830. Aug. 24, 1959.

The jet separation of gaseous isotope mixtures is described. The gas is fed through the axis into a hollow rotating disk that is interiorly provided with blades, ejected at supersonic velocity through a peripheral slit, and separated by means of a diaphragm into a central space being kept at 30 to 100 mm pressure and being provided in its annular part with blades to convert kinetic into potential energy. To increase the capacity, several disks can be mounted on one axis. (NPO)

9311 METHOD OF ISOTOPE ENRICHMENT. (to Ciba S. A.). French Patent 1,206,682. Aug. 31, 1959.

Nitrogen and/or oxygen isotopes are separated by rectification of NO. The light fraction is subjected to catalytic isotope exchange with aqueous nitric acid or with acid solutions of salts of nitric or nitrous acid and returned to the rectification apparatus, a description of which is given. An atomic rearrangement in the molecules of the heavy fraction may be effected by contacting this fraction with nitric acid which contains nitrous fumes. (NPO)

9312 METHOD FOR SEPARATING HYDROGEN ISOTOPES. K. E. Holmberg. French Patent 1,207,143. Aug. 31, 1959.

A method is given for separating hydrogen isotopes comprising rectification of $(CH_3)(C_2H_5)NH \cdot H_2S$ (b.p.50 to 55°C) or $C_3H_7NH_2 \cdot 0.7\ H_2S$ (b.p. 60 to 65°C) followed by separate exchange of the top and bottom fractions with natural water and return of the resulting two amine compound fractions to the column as the reflux and the feed, respectively. The effluents of the two exchange steps constitute light and heavy water, respectively. (NPO)

9313 PROCESS AND EQUIPMENT FOR SEPARATING ALKALI METAL, NOTABLY LITHIUM, ISOTOPES. (to Société Anonyme des Manufactures des Glaces et Produits Chimiques de Saint-Gobain). French Patent 1,207,421. Sept. 7, 1959.

Alkali metal (notably lithium) isotopes are separated by countercurrent electromigration in one or more slightly inclined beds of molten nitrate which extend between a cathode and an anode space, the beds and spaces being hollowed out of a rectangular steatite block. Nitric acid vapor is continuously fed to the cathode space to reconvert the deposited alkaline metal to nitrate, while the flow in the beds is reduced by means of an inert granular filler (steatite, zircon, polytetrafluoroethylene, etc.). The steatite block is contained in a heated glass tube that is connected to a suction device. (NPO)

9314 ELECTRICAL DISCHARGE APPARATUS FOR ISOTOPE SEPARATOR. J. Slepian. French Patent 1,207,468. Sept. 7, 1959.

An apparatus is given for the separation of ionized isotopes in which ions, produced by an electric-arc discharge of short duration, are simultaneously subjected to an electric and a magnetic field and collected on a series of collector plates. (NPO)

9315 IMPROVEMENT IN DRAW-OFF METHODS IN ISOTOPIC ENRICHMENT PROCESSES UTILIZING BITHERMAL EXCHANGE. (to Commissariat à l'Énergie Atomique). French Patent 1,209,633. Sept. 21, 1959.

A number of flow-sheets are given for bithermal isotope exchange processes that can be applied for deuterium enrichment by catalytic exchange between hydrogen and ammonia. (NPO)

9316 PRODUCTION OF ISOTOPES. (to Esso Research and Engineering Co.). French Patent 1,221,324. Jan. 11, 1960.

Isotopes are produced by provoking a nuclear explosion, either by fission or by fusion, in a salt dome, preferably in the presence of a proper radiation (e.g., neutron) target (e.g., Co^{59}). The isotopes are recovered by first treating the molten salt mass with a proper chemically reacting sweeping agent (e.g., CO) and then dissolving the mass in water in a manner similar to that used in rock-salt production. (NPO)

MATHEMATICS AND COMPUTERS

9317 (AFOSR-TN-60-1060) ON EXISTENCE IN THE LARGE OF SOLUTIONS OF HYPERBOLIC PARTIAL DIFFERENTIAL EQUATIONS. Technical Note No. 18. John P. Shanahan (Johns Hopkins Univ., Baltimore). July 1960. 15p. Contract AF18(603)-41.

A discussion is given of the existence in the large of solutions of $z_{xy} = f(x,y,z,p,q)$, where $z(x,0)$ and $z(0,y)$ are prescribed. Theorems proved are analogs of theorems in

ordinary differential equations. A condition on f sufficient to ensure existence in the large is $|f(x,y,z,p,q)| \leqq \varphi(|z| + |p| + |q|)$, where $\varphi(t)$ is a positive, nondecreasing, continuous function, defined for $t \geqq 0$, satisfying $\int^{\infty} dt/\varphi(t) = \infty$. This is an analog of a theorem of Wintner in ordinary differential equations. An analog of another theorem of Wintner on the asymptotic behavior of solutions is proved. (auth)

9318 (IS-189) EVALUATION OF THE ZEROS OF CROSS-PRODUCT BESSEL FUNCTIONS. L. Jackson Laslett and William Lewish (Ames Lab., Ames, Iowa). Sept. 1960. 174p. Contract W-7405-eng-82.

Computational results for the characteristic values and solutions of Bessel's equation are presented. Specifically, the results pertain to the first two solutions subject to the Neumann boundary condition at r = a,b and to the first solution subject to the Dirichlet condition, when (b-a)/(b+a) is small (0.1, 0.01, and 0.001). Approximate analytic formulas are derived to complement the computational results. The possible application of the data to phenomena involving the interaction of an intense circulating beam and the electromagnetic fields within a particle accelerator is indicated, as is also the utility of the results for estimation of the loss-factor, Q, for resonant electromagnetic modes of possibly high order within a toroidal vacuum chamber of rectangular cross section. (auth)

9319 (KAPL-M-MH-3) A REMARK ON THE PROPAGATION OF ERROR. M. Halperin (Knolls Atomic Power Lab., Schenectady, N. Y.). Oct. 27, 1960. 10p. Contract W-31-109-Eng-52.

The fact that the variance of a function of random variables, as usually obtained by using the Taylor's series expansion to linear terms as an approximation to the function, generally depends on the parameter being estimated is pointed out and discussed. The use of this fact in computing approximate confidence intervals for the parameter is shown. The confidence interval obtained generally differs nontrivially from the approximate interval ignoring the dependence of the variance on the parameter when the percentage standard deviations of one or more components of the function are not small. Examples are given. (auth)

9320 (NAA-SR-Memo-5452) FEASIBILITY OF SPECTRAL MEASUREMENTS AND COMPUTATIONS IN CORRESPONDING ORDERS OF ACCURACY. F. H. Clark (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 1, 1960. 15p.

An analysis was made of the accuracy of experimental measurements compared to Monte Carlo calculations of leakage spectra measurements. It was found possible to make measurements with the detail and accuracy of a Monte Carlo calculation subject to qualifications on background radiation intensity, source strength, collimator efficiency, and detector efficiency. The qualifications for the above parameters are enumerated. Both experimental and statistical accuracy were found to be of the order of 10 to 20% for spectral measurements. (C.J.G.)

9321 (ORNL-3054) THE STRUCTURE OF AN ALGOL TRANSLATOR. A. A. Grau (Oak Ridge National Lab., Tenn.). Feb. 9, 1961. 62p. Contract W-7405-eng-26.

The theory underlying a translator program, which is needed on a computer whenever programs written in the algorithmic language ALGOL are to be used on that machine, is described. The approach followed is related to the recursive sequential methods. These methods have been simplified by the explicit use of recursive subroutines based on syntactic skeletons defining the ALGOL language. Specifications for a translator based on these principles are given in machine-independent form. They include substantial advances over those used in the design of the first ALGOL translator for the ORACLE. (auth)

9322 (JPRS-6598) INFORMATION CAPABILITIES OF MODERN ELECTRONIC COMPUTERS. V. M. Glushkov. Translated from Izvest. Vysshikh Ucheb. Zavendenii Elektromekh., 3: No. 7, 3-8(1960). 7p.

A review of the capabilities and limitations of electronic computers is presented. It is noted that a computer is limited by the memory capacity, operating speed, and carrying capacity of the input and output channels. The outstanding advantages of machines over humans in various data manipulations are speed and accuracy. (J.R.D.)

9323 COMPLEX ORTHOGONAL AND ANTIORTHOGONAL REPRESENTATION OF LORENTZ GROUP. Behram Kurşunoğlu (Univ. of Miami, Coral Gables, Fla.). J. Math. Phys., 2: 22-32(Jan.-Feb. 1961).

By using the fact that a plane electromagnetic wave is described by two Lorentz invariant statements, a complex orthogonal representation of the Lorentz group, including charged fields, is discussed. The representation provides the possibility of a combined study of the P, C, T symmetry operations for spin ½ and spin 1 fields. In particular, the chargelessness of the neutrino as a complex fermion field results from a reducible three charge states representation of the complex group. (auth)

9324 DYNAMICS OF NONLINEAR STOCHASTIC SYSTEMS. Robert H. Kraichnan (New York Univ., New York). J. Math. Phys., 2: 124-48(Jan.-Feb. 1961).

A method for treating nonlinear stochastic systems is described which it is hoped will be useful in both the quantum-mechanical many-body problem and the theory of turbulence. In this method the true problem is replaced by models that lead to closed equations for correlation functions and averaged Green's functions. The model solutions are exact descriptions of possible dynamical systems, and, as a result, they display certain consistency properties. For example, spectral components of Green's functions which must be positive-definite in the true problem automatically are so for the models. The models involve a new stochastic element: Random couplings are introduced among an infinite collection of similar systems, the true problem corresponding to the limit where these couplings vanish. The method is first applied to a linear oscillator with random frequency parameter. The mean impulse-response function of the oscillator is obtained explicitly for two successive models. The results suggest the existence of a sequence of model solutions which converges rapidly to the exact solution of the true problem. Applications then are made to the Schrödinger equation of a particle in a random potential and to Burgers' analog for turbulence dynamics. For both problems, closed model equations are obtained which determine the average Green's function, the amplitude of the mean field, and the covariance of the fluctuating field. The model solutions can be expressed as sums of infinite classes of terms from the formal perturbation expansions of the solutions to the true problems. It is suggested that correspondence to stochastic models may be a useful criterion to help judge the validity of partial summations of perturbation series. (auth)

9325 COMPUTATIONAL METHODS FOR ANALYSIS OF RESONANCE TRANSMISSION DATA FOR S-WAVE NEUTRONS. J. E. Lynn (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Instr. & Methods, 9: 315-27(Dec. 1960). (In English)

Computational methods that may be used for the analysis

of neutron transmission data in terms of neutron resonance parameters are described. These methods include a self-consistent scheme for correcting the experimental data to obtain a transmission dip "area" and for simultaneously comparing it with the theoretical area function to obtain a relation between a pair of resonance parameters. Several such functional relations (from measurement of neutron transmission through different sample thicknesses) serve to find the "best values" of the parameters by least squares fitting. Diagrams of several families of curves describing the theoretical transmission dip area function (with and without Doppler broadening of the effective resonance cross section are included). An example of the use of these methods on actual experimental data is given. For the 66.14-ev resonance in the cross section of U^{238}, the neutron width was found to be 25.1 ± 1.2 Mev and the total radiation width was 25.1 ± 1.4 Mev. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

9326 (CF-59-8-133) MOLTEN SALT-GRAPHITE COMPATIBILITY TEST. RESULTS OF PHYSICAL AND CHEMICAL MEASUREMENTS. R. J. Sheil, R. B. Evans, and G. M. Watson (Oak Ridge National Lab., Tenn.). Aug. 31, 1959. 10p.

Observed changes in dimensions, weight, and chemical composition of "impervious" graphite rods in contact for 1 year with flowing liquid $LiF-BeF_2-UF_4$ (62–37–1 mole %) in a pump loop at 1300°F are given. On the average, the change in diameter was <0.02%, and the change in weight was <0.03%. Chemical analyses of machine cuttings from the graphite rods show average uranium and beryllium concentrations of ~20 and 100 ppm, respectively. (auth)

9327 (DMIC-Memo-83) REFRACTORY METALS IN EUROPE. R. I. Jaffee (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Feb. 1, 1961. 8p. (PB-161233).

A review of activities in Europe related to refractory metals is presented. Included are discussions of applications, research, and production. It is noted that, in general, refractory-metal development seems to be based on the traditional, well-established markets. An uncertainty in ability to forecast future requirements for refractory metals is shared with producers in the U. S. (J.R.D.)

9328 (HW-59276) CONTINUOUS ARC FUSION OF URANIUM DIOXIDE POWDER. H. W. Newkirk (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 17, 1959. 6p.

Exploratory experiments were made to prepare fused uranium dioxide continuously by dropping low-density powder through the plasma of a carbon arc. X-ray-diffraction analysis indicates that no impurities were introduced during fusion. The fused particles are pure and dense, and it is concluded that the method is feasible. (J.R.D.)

9329 (HW-59740) INDUCTION MELTING OF URANIUM DIOXIDE POWDER. H. W. Newkirk (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 23, 1959. 5p.

Results are reported of exploratory experiments on the preparation of fused UO_2 by induction heating of low-density powder in graphite crucibles. Fused UO_2 can be prepared by induction heating. The product is contaminated by considerable quantities of UC. Since this material has poor corrosion resistance in water at high temperature, its presence in the fused oxide is objectionable. The fused UO_2 is unsuitable for swaged fuel elements for water-cooled reactors. (W.L.H.)

9330 (LAMS-2393) A HIGH-TEMPERATURE METAL RESISTANCE FURNACE FOR VACUUM OR PRESSURE OPERATION. M. R. Nadler, J. E. Runyan, and C. P. Kempter (Los Alamos Scientific Lab., N. Mex.). Dec. 1959. 17p. Contract W-7405-eng-36.

A metal resistance furnace is described for operation to 3000°C in vacuo or at pressures to 100 atm of inert or reducing gas. Tungsten or tantalum heater tubes give a uniform heating chamber approximately 1 in. in diameter by 3 in. in length. (auth)

9331 (NAA-SR-5689) PREPARATION OF THORIUM-ALUMINUM ALLOYS BY DIRECT THORIA REDUCTION. D. O. Raleigh (Atomics International Div., North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1960. 29p. Contract AT(11-1)-GEN-8.

Thoria was reduced from molten cryolite by aluminum with near-quantitative yields to make Al–20 wt.% Th alloys. The reaction at 1050°C is complete in ½ hr. Alloys up to 40 wt.% Th may be produced. The reaction is presumably driven by the high free energy of formation of $ThAl_3$, estimated at 36.5 kcal. Metallic sodium is produced as a possibly useful by-product. (auth)

9332 (NAA-SR-Memo-5729) TIN OXIDES AND TITANIUM OXIDES. UNCLASSIFIED BIBLIOGRAPHY. Marianne J. Chapman (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 28, 1960. 15p.

References (174) were taken from books, reports, patents, and journals for the period 1947 to 1960. (W.L.H.)

9333 (NDA-2145-5) CARBIDE FUEL DEVELOPMENT. Progress Report, May 1, 1960 to July 31, 1960. A. Strasser (Nuclear Development Corp. of America, White Plains, N. Y.) and K. Taylor (Carborundum Co., Niagara Falls, N. Y.). Aug. 30, 1960. 10p. Contract AT(30-1)-2303.

Fabrication studies of natural UC were completed. Higher sintering temperatures or changes in binder mixtures did not improve densities. Fabrication of enriched UC for the irradiation tests was completed. An average density of 12.8 g/cc (~94% of theoretical) was obtained, with some as high as 13.1 g/cc (~96% of theoretical). The UC-cladding compatibility tests were completed. The longest tests were 4000 hr at 820°C. Visible reactions occurred between UC and Zircaloy-2, beryllium, Inconel-x, and 2.5 Cr–1 Mo alloy. The plutonium facility is complete and leaktight with all the equipment installed. (For preceding period see NDA-2145-4.) (W.L.H.)

9334 (NMI-2091) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report for November 1960. (Nuclear Metals, Inc., Concord, Mass.). Dec. 27, 1960. 28p. Contract AT(30-1)-1565.

Fabrication techniques were investigated for hot extruded uranium dioxide fuel specimens for irradiation in the VBWR. Honeycomb type ribbon-candy and spiral fuel elements are discussed. The design concepts and model forming are given for the ribbon-candy fuel element. Yttrium fabrication work emphasized the rolling of extruded bar stock into sheet form. Plant designs for the fabrication of ThO_2 fuel elements containing 5% U^{233} has continued at the experimental level, and in studying

processing details and discussions on plant layout and choice of equipment. The effects of neutron irradiation at relatively high α-phase temperatures on the behavior of metastable β-phase uranium-base alloys and the volume instability characteristics of these materials were investigated. The role of intermetallic precipitates in the mechanisms of zirconium alloy corrosion in high-temperature steam was studied. The preparation, β-phase boundary study, and thermal analysis of ternary and quaternary beryllium alloys was continued. High-temperature tensile tests were performed on beryllium and Be-8 at.% Ni alloys. (For preceding period see NMI-2090.) (B.O.G.)

9335 (NP-9789) DEVELOPMENT OF EXO-REACTANT INORGANIC ADHESIVE SYSTEM. Quarterly Progress Report No. 5 Covering Period October 1–December 31, 1960. William Bassett and Roger A. Long (Narmco Industries Inc., San Diego, Calif.). Jan. 1, 1961. 23p. Contract NOas 60-6061-c.

Activities in a program of evaluation for exothermic adhesive bonding in overlap evaluations and for adapting the exothermic bonding process to fabrication of stainless steel honeycomb panels are reported. The overlap bonding evaluation was completed. Results indicated that the bonds were sufficiently ductile to withstand mechanical shock and to resist peel. Procedures for fabricating honeycomb panels up to 2 by 2 in. were developed and specifications written. (auth)

9336 (SCTM-351-60(25)) GENERAL PURPOSE ADHESIVES. H. Moore (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 10p.

Various failures resulting from attempts to bond rubber to metal are discussed. Experimental bonding techniques using various rubber-base adhesives are described. Also included with the most impressive bonding techniques and test results are proposed specifications that describe both the necessary preparation of rubber surfaces and the methods of applying adhesives which proved to be the most satisfactory as a result of experimental testing. (auth)

9337 (TID-3208) TITANIUM METALLURGY: A BIBLIOGRAPHY OF CONFIDENTIAL U. S. ATOMIC ENERGY COMMISSION REPORTS AVAILABLE THROUGH THE CIVILIAN APPLICATION PROGRAM. (Technical Information Service Extension, AEC). Sept. 1956. Decl. Mar. 31, 1960. 18p.

This bibliography contains 54 annotated references to reports on titanium metallurgy. References are included to reports written prior to August 1, 1956. Author, subject, and report number indexes are provided. (auth)

9338 (AEC-tr-4416) CATHODIC PROCESSES IN THE DEPOSITION OF BERYLLIUM FROM FUSED ELECTROLYTES. M. V. Smirnov and L. V. Ivanovskii. Translated from Zhur. Fiz. Khim., 32: 2174-82(1958). 19p. (Includes original, 9p.).

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 2789.

9339 (NP-tr-547) NEWS OF HIGHER EDUCATIONAL INSTITUTIONS, NONFERROUS METALLURGY. Translation of Izvestiya Vysshikh Uchebnykh Zavedenii, Tsvetnaya Metallurgiya No. 1, 59-66; 91-8 (1959). 23p.

The feasibility of preparing a Be–Al–Cu alloy by the reduction of vaporous beryllium chloride in Al–Mg and Cu–Mg alloys was investigated. A process is reported for the preparation of Mg–Zr alloys by first preparing a Zn–Mg fused-salt mixture. Potassium fluorozirconate is mixed continuously with the fused-salt mixture. The magnesium thermally reduces the zirconium from the potassium fluorozirconate and the excess magnesium fuses with the zirconium to form the alloy. (W.L.H.)

9340 LUBRICANTS FOR NUCLEAR POWER PLANT. C. G. Nightingale (Esso Petroleum Co. Ltd., [London]). Brit. Power Eng., 2: 31-4(Jan. 1961).

The lubrication requirements of British commercial nuclear power plants are given, and lubricant development is discussed. The conditions include low and high radiation levels, hot CO_2 under pressure, and high temperatures. Ordinary oils, greases, and soaps were not suitable for the extreme conditions, so carbon black greases were developed. (T.R.H.)

9341 REFRACTORY METALS: TANTALUM, NIOBIUM, MOLYBDENUM, RHENIUM, AND TUNGSTEN. Clifford A. Hampel. Ind. Eng. Chem., 53: 90-6(Feb. 1961).

The refractory metals, so-called because of their elevated melting points, are Ta (m.p. 3000°C), Nb (m.p. 2468°C), Mo (m.p. 2610°C), Re (m.p. 3130°C), and W (m.p. 3410°C). They are all characterized by great strength and high thermal, chemical, and physical stability. The processing of raw materials to produce the pure metal, chemical and physical properties, corrosion properties, and present and potential applications are summarized for each metal. Emphasis is placed on the industrial chemical aspects of the problems and special techniques involved in the preparation, handling, and application of these metals. (auth)

9342 REACTIVE METALS: ZIRCONIUM, HAFNIUM, AND TITANIUM. Donald R. Spink (Carborundum Metals Co., Akron, N. Y.). Ind. Eng. Chem., 53: 97-104(Feb. 1961).

The reactive metals—zirconium, hafnium and titanium—are finding increased usage in the chemical process industry. Reduced cost, availability, and an inertness to wide variations in chemical exposure are the three factors behind the acceptance of these transition metals by today's materials engineer. Applications where zirconium or titanium have replaced other materials of construction in the chemical industry are given. (auth)

9343 CHROMIUM AND VANADIUM. Earl T. Hayes (Bureau of Mines, Washington, D. C.). Ind. Eng. Chem., 53: 105-7(Feb. 1961).

The technical status of chromium and vanadium is reviewed. Methods of producing the metals in high-purity form and the effect of specific impurities, notably oxygen, nitrogen, and carbon are discussed in general terms. Problems and profits to be realized from alloying are presented. (auth)

9344 PREPARATION OF HIGH-PURITY VANADIUM METAL BY THE IODIDE REFINING PROCESS. O. N. Carlson and C. V. Owen (Iowa State Univ., Ames). J. Electrochem. Soc., 108: 88-93 (Jan. 1961).

The preparation of vanadium of 99.95+ % purity by the Van Arkel-deBoer iodide process is described. Conditions for optimum growth rate and maximum purity were determined. Data on impurity transfer from the feed to the hot filament are presented together with a discussion of contamination by the retort. The quality of vanadium obtained from feed material prepared by bomb reduction and by a sponge process is compared. Some physical properties of this metal are reported. An apparatus designed to prepare several pounds per batch is described. (auth)

9345 THE PROMISE OF LIQUID METALS. J. H. Amman and T. S. Sprague (Babcock and Wilcox Co.). Nuclear Energy, 11, 13-16(Jan. 1961).

Research and development work carried out on liquid metal reactor coolant systems is reviewed. Some of the problems of generating steam with sodium and how they were met in specific designs are discussed. The chemical activity of sodium and its radioactivity acquired in passing through the reactor created special problems in design and materials. The Submarine Intermediate Reactor Program, which led to the design and installation of the Seawolf power plant, is described. All the development work and lessons learned in operation of the Atomic Power Development Association and Sodium Reactor Experiment units were incorporated into designs of the single-wall tube type. (M.C.G.)

9346 GERMANIUM AND SILICON. (Office of Technical Services, Washington, D. C.). Sept. 1960. 21p. (SB-437). $0.10(OTS).

The 374 reports and translations on germanium and silicon added to the OTS collection from 1950 to September 1960 are listed. (auth)

9347 PHYSICS OF SEMIDONDUCTORS. A. F. Ioffe. Translation of "Fizika Poluprovodnikov" (A Publication of the Academy of Sciences, USSR, Moscow, 1957). New York, Academic Press Inc., 1960. 446p. $12.50.

An extensive treatment of the physics of semiconductors is given. Solid electrolytes, metals, and electronic semiconductors are covered in both their theoretical and experimental aspects. The fundamentals of the quantum theory of semiconductors are given. The properties of the crystal lattice and the methods of measuring the basic properties of semiconductors are discussed. (D.L.C.)

9348 METHOD OF PREPARING CARBON WITH SUPERIOR MODERATOR PROPERTIES. (to N. V. de Bataafsche Petroleum Maatschappij). French Patent 1,190,331. Mar. 31, 1959.

Carbon molding pieces are manufactured from such carbon as gives little or no gas evolution during reactor operation and deuterated, preferably polycyclic, hydrocarbons with a m.p. above 50°C, the latter being prepared by isotopic exchange between hydrocarbons and deuterium. After molding, the objects are subjected to a homogenizing treatment below 300°C by means of high energy radiation, e.g., fast electrons or reactor radiation. The atomic D/C ratio in the final product has to be at least 1:5, e.g., 2:7. Said molding pieces are characterized by superior moderator properties, low neutron absorption, and better retention of shape than graphite. Applications are: moderator, reflector, or constructional material for nuclear reactors. (NPO)

9349 POROUS MEMBRANES WITH A VERY FINE POROSITY, AND METHOD OF THEIR MANUFACTURE. (to Commissariat à l'Énergie Atomique). French Patent 1,197,982. June 8, 1959.

Composite membranes are described consisting of a rigid support with pores of the order of magnitude of 30 μ (e.g., fritted stainless steel) on which a thin layer of Al_2O_3 or TiO_2 powder, having a grain size of the order of magnitude of 0.03 μ, is compressed by rolling, stamping, or otherwise. If required an intermediate powder layer, the grain size of which is of the order of magnitude of 1 μ, can be applied and bonded to the support by sintering. Said membranes are characterized by an excellent mechanical resistance; they are particularly adapted to ultrafiltration and separation by gaseous diffusion. (NPO)

9350 METHOD FOR THE PREPARATION OF CARBON WITH STRONG MODERATOR PROPERTIES. (to N. V. de Bataafsche Petroleum Maatschappij). French Patent 1,198,621. June 15, 1959.

Deuterated carbon is prepared by countercurrently contacting deuterium at 550 to 750°C with B-, N-, and S-free carbon which contains bonded hydrogen (e.g., coke, gas, and black) and has a grain size of 100 to 250 μ. Prior to the isotopic exchange the carbon is subjected to a vacuum in order to remove volatile constituents and treated with H_2 to decrease the formation of lower hydrocarbons during the exchange. The deuterated carbon has better moderator properties than graphite and its preparation requires lower temperatures. Applications are: moderator and reflector material and heat-transfer agent in nuclear reactors, and preparation of porous dispersion fuels. (NPO)

9351 METHOD FOR MANUFACTURING LAMINATED SHEETS FOR PROTECTION AGAINST RADIOACTIVE WASTES, AND PROTECTING AND PACKAGING MEANS MANUFACTURED WITH THESE SHEETS. (Papierfabrik Wilhemstal Wilhelm Ernst). French Patent 1,201,905. July 15, 1959.

A description is given of laminated sheet, consisting of a first layer of absorbing and preferably fibrous material (e.g., filter or blotting paper, or felt), a second layer of adhesive, impermeable, and hydrophobic material (e.g., wax, bitumen, a polyvinyl or polyacrylic compound, or a polyhydrocarbon), and a third (and fourth) layer of rigid material more or less impermeable to liquids (e.g., metal (aluminum), polyvinyl chloride, polyethylene, or cardboard). These sheets can be used for covering laboratory tables and walls, for radiation protection (manufacture of clothes, etc.), or for packaging radioactive waste (manufacture of boxes, bags, etc.). (NPO)

9352 METHOD OF SINTERING METALLIC OXIDES. (to U. S. Atomic Energy Commission). French Patent 1,204,910. Aug. 10, 1959.

High-density UO_2 bodies are obtained by mixing UO_2 powder with 1 to 3 wt.% CaH_2, compacting the mixture, slowly heating the compact under vacuum to a temperature above 675°C, and finally sintering at 1700 to 1900°C. Above 675°C. CaH_2 is decomposed into calcium and hydrogen. The calcium partly reduces the UO_2 at sintering temperature to uranium. The voids thereby formed improve the volumetric diffusion, giving rise to a higher density. (NPO)

9353 PREPARATION OF HIGH PURITY GRAPHITE. (to Siemens-Planiawerke A. G. für Kohlefabrikate). French Patent 1,205,756. Aug. 17, 1959.

After the well-known purification with gaseous halogens the graphite is washed out with CO. Alternatively the washing may comprise a treatment with high-purity N_2 at 2700°C until all halogens and volatile halides have disappeared, followed by a treatment with CO. High-purity CO is preferably made from CO_2 and active carbon at 1000°C. (NPO)

9354 PREPARATION OF NUCLEAR REACTOR CARBON WITH IMPROVED MODERATOR PROPERTIES. (to N. V. de Bataafsche Petroleum Maatschappij). French Patent 1,208,459. Sept. 14, 1959.

Molded objects for application as moderator, reflector, or heat-transfer agent are manufactured from deuterated carbon, prepared by carbonization of deuterated polycyclic hydrocarbons, hydrogenated carbon and deuterium, or deuterium-carbon compounds by isotopic exchange at 500 to 1000°C, on the one hand and deuterated polycyclic hydrocarbons, having a m.p. above 50°C on the other. The process comprises either mixing both components and pressing or pressing the carbon and then impregnating it with the hydrocarbon. The pressed object is finally thermally homogenized at 500 to 1000°C or homogenized by high-energy radiation at 100 to 300°C. The atomic ratio D/C in the final

product should be at least 1:5, e.g., 2:7. The objects are said to have a considerably higher strength, better form retention, and better moderator properties than the usual graphite/binder molded pieces; their neutron absorption is said to be very low. (NPO)

9355 LUBRICATING OIL THAT IS RESISTANT TO ATOMIC RADIATIONS. (to Socony-Mobil Oil Co., Inc.). French Patent 1,209,089. Sept. 21, 1959.

The increase in viscosity of mineral lubricating oils that are subjected to atomic radiation is retarded by adding well-known soluble organic Cd, Pb, or Fe salts, such as Pb oleate, Fe naphthenate. However, Cd di-or mono-alkyl-dithiocarbamate with alkyl groups of 3 to 20 C atoms is preferred. The metal content of the oil should be 0.5 to 5 wt. %. (NPO)

9356 OIL COMPOSITIONS WITH AN INCREASED STABILITY TOWARDS FREE RADICALS. (to Shell Research Ltd.). French Patent 1,209,553. Sept. 21, 1959.

The irradiation, photochemical, thermal, and oxidation stability of mineral and synthetic oils is improved by adding 1 to 30 (preferably 4 to 15) wt.% of a dihydro-aromatic compound composed of three condensed benzene nuclei or of one benzene nucleus condensed with one heterocyclic nucleus (e.g., dihydrophenanthrene or dihydrothionaphthene). Preferably 1 to 30 (2 to 10) wt.% of a chain transfer agent that steers the free radical reactions is also added; mercaptans having more than 8 C atoms or thionaphthols are preferred for this purpose. The ratio of the dihydro-aromatic compound and the chain transfer agent should lie between 1:1 and 10:1. (NPO)

9357 IMPROVEMENTS IN MATERIALS FOR CONTROL RODS. (to General Electric Co., Ltd.). French Patent 1,212,642. Oct. 19, 1959.

Ceramic neutron-absorbing materials, consisting of B_2O_3 and one or more of the oxides of Mg, Ca, Al, and Si, the B-atoms constituting 12 to 35% of the total number of atoms. The materials are prepared by either melting and casting or pressing and sintering a powderous mixture; a combination of both methods is also possible, e.g., a mixture of MgO (20), B_2O_3 (9), and SiO_2 (1 mole) is melted at 1400° and cooled; the mass is ground, pressed, and sintered at 1100 to 1300°C. A tubular control rod is described which consists of 60 annular elements manufactured in this way and having an external diameter of 62 mm and a wall thickness of 6 mm, piled up in a double-walled stainless-steel tube. (NPO)

9358 METHODS FOR IMPROVING THE IMPERMEABILITY OF CARBON OBJECTS. (to United Kingdom Atomic Energy Authority). French Patent 1,215,384. Nov. 16, 1959.

Carbon objects are made less porous by a first impregnation, preferably started under vacuum and finished under pressure, with a suspension of finely divided carbon in a liquid furan compound (e.g., partially polymerized furfuryl alcohol), followed by resinification and carbonization of this compound. Then a second sequence of similar treatments is applied with omission of the finely divided carbon. Different surfaces of the object are separately and alternately treated. The resinification is effected with an acid catalyst (e.g., 0.05 to 1.0 vol.% HCl) in a furfuryl alcohol atmosphere; alternatively an acid atmosphere can be applied to cause a rapid resinification at the surface. The temperature during the resinification is 40 to 220°C. Carbonization takes place by enveloping the impregnated object in finely divided carbon or in an inert atmosphere and heating for at least 3 days from 100 to 1000 to 1350°C. A final thermal treatment for at least 3 days at 1350 to 2800°C is given to improve the oxidation resistance. (NPO)

Corrosion

9359 (ANL-6243) STUDIES OF CORROSION BY MOLTEN ZINC AND CADMIUM SYSTEMS. John P. DeKany, Henry W. Lavendel, and Leslie Burris, Jr. (Argonne National Lab., Ill.). October 1960. 44p. Contract W-31-109-eng-38.

A corrosion program was undertaken in conjunction with development of pyrometallurgical processes employing liquid metal solvents as processing media. The metal solvents under consideration for uranium, plutonium, and thorium were zinc, cadmium, and magnesium, either alone or in various combinations with each other. The objective of the program was to find suitable container materials for the various liquid metal systems encountered. The corrosion program consisted of 100-hr static tests designed to screen a large number of materials. Promising materials were then subjected to 1000-hr dynamic capsule tests, or used in forced-convection or thermal-convection loops. The latter enabled an assessment of mass transfer corrosion. Zinc-base systems were tested at temperatures up to 750°C, and the cadmium-base systems were tested at temperatures of 550 to 700°C. Magnesium was generally the other constituent, being used in processes either as a reducing agent or in concentration sufficient to provide certain desirable solubility relations. The corrosion behavior of dilute zinc-cadmium solutions was also investigated, zinc being used to provide desirable solubility effects. (auth)

9360 (CF-51-11-204) PROCEEDINGS OF THE FIRST INFORMATION MEETING ON HYDROXIDE AND METAL INTERACTION [HELD AT OAK RIDGE NATIONAL LABORATORY ON] NOVEMBER 13 AND 14, 1951. (Oak Ridge National Lab., Tenn.). Aug. 31, 1953. Decl. Nov. 20, 1959. 144p.

The corrosion of metals by molten hydroxides is discussed, and results of corrosion tests made at several laboratories are compared. Research results are reviewed on NaOH corrosion of metals, static corrosion by molten caustic at 1500°F, dynamic corrosion by molten caustic at 1500°F, NaOH-NaH systems, corrosion by fused caustic at high temperatures, purification techniques for NaOH, mechanisms of some corrosion reactions, screening tests on metals, alloys, and ceramic materials, and static corrosion by hydroxides. The metallurgical and chemical aspects of interaction between metals and hydroxides are discussed. (C.H.)

9361 (CF-57-10-52) THE CORROSION RESISTANCE OF 86% Fe-5% Si-5% Cu-4% B BRAZING ALLOY TO HIGH-TEMPERATURE LITHIUM. D. H. Jansen (Oak Ridge National Lab., Tenn.). Oct. 4, 1957. Decl. Mar. 30, 1960. 6p. Contract W-7405-eng-26.

The 86% Fe–5% Si–5% Cu–4% B brazing alloys show better corrosion resistance to high-temperature lithium than any of the nickel-base brazing materials tested to date. A perferential leaching of the surface of the alloy to a depth of 2 to 3 mils was observed on the alloy specimens tested in lithium at 1500°F. A greater weight loss, associated with subsurface voids, was found on specimens tested under dynamic conditions than was observed on the alloy when statically tested at the same temperature. This greater severity of attack in the presence of dynamic lithium was observed in other lithium-corrosion systems. (auth)

9362 (CF-59-6-110) CORROSION STATUS: SULFEX-THOREX (Ni-o-nel) AND DAREX–THOREX (TITANIUM) AS OF JUNE 12, 1959. W. E. Clark (Oak Ridge National Lab., Tenn.). June 29, 1960. 14p.

Current results indicate probable over-all rates of about 0.2 mils/month for titanium vs. 1.5 to 3.0 mils/month for Ni-o-nel. Tests are not 100% comparable due to changes made in flowsheet conditions, but they have been of sufficient variation and length as to allow good predictions to be made. Both metals show some tendency toward local attack in Thorex solutions. These tendencies are increased by poor welding techniques. There is a possibility that a Ni-o-nel dissolver could be used for interim Zirflex processing although the rates obtained in scouting tests are relatively high (6 to 8 mils/month). Titanium shows no promise of usefulness in either Zirflex or Sulfex on the basis of scouting tests. It can be used for dissolution of U-Al fuels in 8M HNO_3-$Hg(NO_3)_2$ (rate < 1 mil/month). If the choice between these two processes were made on the basis of present corrosion results alone, Darex-Thorex would be chosen. (auth)

9363 (DMIC-144) STRESS-CORROSION CRACKING–A NONTECHNICAL INTRODUCTION TO THE PROBLEM. Warren E. Berry (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Jan. 6, 1961. 29p. Contract AF33(616)-7747. (PB-151103).

Stress-corrosion cracking is reviewed from a nontechnical viewpoint. The recognition of this form of corrosion cracking is discussed. The environments most likely to cause stress-corrosion cracking are pointed out for each alloy system. The effects of material composition, stress, environment, temperature, and time on stress-corrosion cracking are discussed, and suggestions are made for controlling these variables. The roles of protective coatings, inhibitors, and cathodic protection in reducing cracking susceptibility are considered. A bibliography of some of the more recent articles on stress-corrosion cracking is included. (auth)

9364 (DP-539) STAINLESS STEEL FAILURES IN SAVANNAH RIVER PLANT REACTOR AREAS. Robert H. McKane, Hugh C. Minton, Jr., and John W. Wade (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Nov. 1960. 59p. Contract AT(07-2)-1.

Three different failures of stainless-steel equipment in the Savannah River Plant reactor equipment complex are described. The failures, which apparently originated on external surfaces, were caused by conditions common to many industrial locations. Nuclear radiation was not evidently a factor. (auth)

9365 (HW-61757(Rev. 2)) EVALUATION OF ALUMINUM FOR USE IN REACTORS COOLED BY HIGH-TEMPERATURE RECIRCULATING WATER. J. A. Ayres (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 5, 1960. 22p. Contract AT(45-1)-1350.

General information is presented for use in evaluating aluminum for use in water-cooled-reactor applications. Included are a discussion of the corrosion and strength of aluminum alloys, a description of operational problems, and suggested programs for immediate and long-range development. It is suggested that aluminum alloys are not usable in high-temperature water-cooling systems; however, it appears that it may be suitable for fuel-element cladding. (J.R.D.)

9366 (HW-66969) FRETTING CORROSION OF ZIRCALOY-2. Progress Report. R. J. Lobsinger (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 30, 1960. 7p. Contract AT(45-1)-1350.

Laboratory autoclaves, ex-reactor loops, and an in-reactor loop were used to investigate fretting corrosion variables. The test systems and results are discussed separately. (L.T.W.)

9367 (K-1461) HYDROLYSIS OF WATER-SATURATED CHLOROFLUOROCARBONS IN THE PRESENCE OF METALS AND THE ASSOCIATED CORROSION. Albert V. Faloon and R. Lynn Farrar, Jr. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Feb. 1, 1961. 20p. Contract W-7405-eng-26.

Experiments were performed to obtain hydrolysis data on water-saturated Coolant-113, -114, -114A, and -317a in the presence of aluminum alloys, copper, and low-carbon steel. The associated corrosion was also investigated. Coolant-316 was also used in the aluminum alloy study. The order of hydrolytic reactivity of the water-saturated chlorofluorocarbon coolants in the presence of aluminum alloys was Coolant-317a > -113 > -114A > -316 ≫ -114. In the presence of copper and steel, the order of hydrolytic reactivity was Coolant-317a > -114A > -113 ≫ -114. The hydrolysis rates of the chlorofluorocarbons were generally highest in the presence of steel and lowest in the presence of copper. Steel samples exposed to chlorofluorocarbons having a high hydrolysis rate were not corroded as much as aluminum samples exposed to chlorofluorocarbons having a lower hydrolysis rate. Neither the steel nor copper samples showed evidence of gross pitting after exposure to wet chlorofluorocarbon systems. In the presence of 3003 aluminum alloy, Coolant-114A is more reactive by at least two orders of magnitude than is the Coolant-114. A discussion of the mechanism of the corrosive attack on aluminum is presented, and it is concluded that a catalytic hydrolysis on the aluminum "barrier film" surface best represents the observed behavior. (auth)

9368 (KAPL-M-AEB-8) DEVELOPMENT OF CORROSION RESISTANT HIGH STRENGTH ZIRCONIUM ALLOYS. INTERIM REPORT NUMBER 2–BINARY ALLOYS. A. E. Bibb, A. P. Beard, and D. L. Douglass (Knolls Atomic Power Lab., Schenectady, N. Y.). July 28, 1960. 16p. Contract W-31-109-Eng-52.

The corrosion resistance of Zr alloys containing 0.5 and 2.0 at.% alloying additives of Ge, Nb, Sn, V, Y, Ti, Ce, Sb, Pb, La, Si, Ta, Te, U, and Mo in water at 680°F and steam at 750°F was investigated. Hydrogen pickup by Zr alloys containing additions of Nb, Sb, and V was studied. (C.J.G.)

9369 (AEC-tr-4345) CORROSION RESISTANCE OF ZIRCONIUM AND ITS ALLOYS. V. V. Andreeva, A. I. Glukhova, E. A. Kamenskaya, L. I. Seleznev, and M. V. Mal'tsev. Translated by Lydia Venters (Argonne National Lab., Ill.) from Russian book "Alloys of Rare Metals" (Redkiye Metally i splavy). Sept. 1960. 17p.

Zirconium and zirconium alloys were machined and hammered into rods at 700 to 900° in air, then heat-treated in vacuum, then corrosion tested. Technical, as well as iodide zirconium, was used. The alloys contained Nb, Mo, Ta, Sn, Sn–Fe, and Sn–Fe–Ni–Cr. Corrosion was tested in HCl, H_2SO_4, and H_3PO_4. It was found that all elements tested increased the strength and decreased the plasticity of iodide zirconium. Alloying technical zirconium with niobium increased plasticity. The strength increases ranged to 19 to 26 kg/mm^2; the elongation and contraction decreased by less than 6%. Alloying zirconium increases its corrosion resistance. (T.R.H.)

9370 INFLUENCE OF REACTOR RADIATION ON THE OXIDATION OF NIOBIUM. J. V. Cathcart and F. W. Young, Jr. (Oak Ridge National Lab., Tenn.). Corrosion, 17: 55t-57t(Feb. 1961).

The effect of neutron irradiation at flux levels of ~10^{12}

nv on the oxidation characteristics of niobium was studied at temperatures near 400°C. No measurable change was detected either in the rate of oxidation of niobium or in the nucleation process associated with the oxidation of niobium. On the basis of estimates of the extent of radiation damage in thin oxide films, it was concluded that the damage resulting from irradiation at currently available neutron flux levels is unlikely to change the number of oxide lattice defects sufficiently to produce a significant change in the oxidation rate. However, it was thought that alteration of a nucleation-type process was possible. (auth)

9371 THIN OXIDE FILMS ON TITANIUM, ZIRCONIUM, MOLYBDENUM AND ALLOYS OF TITANIUM. V. V. Andreeva and E. A. Alekseeva (Inst. of Physical Chemistry, the Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 134: 106-9(Sept. 1, 1960). (In Russian)

The kinetics of the oxidation of Ti, Zr, Mo, a Ti alloy with 10% Mo, and a Ti alloy with 3% Al and 5% Cr at a temperature of 50 to 400°C were studied by determining the increase in thickness of the oxide layer by means of a method based on the polarization of reflected light. The oxidation became noticeable at 50°C for Zr, 100°C for Ti and the Ti alloy with 10% Mo, and at 150°C for Mo and the Ti alloy with 5% Cr and 3% Al. The rate of oxidation is expressed by the equation $L = k \lg (k_1 t + k_2)$ where L is the thickness of the oxide layer and t is the time of oxidation. At higher temperatures the parabolic expression $L^2 = k_3 t$ determined the rate of oxidation. The more rapid increase in thickness of the oxide film started at 200°C for Zr and Mo and at 350°C for the Ti alloy with 10% Mo, Ti itself, and the Ti alloy with 5% Cr and 3% Al. The composition of the oxide film at various temperatures is discussed. The addition of molybdenum to titanium improved the oxidation resistance of titanium. Water vapor had a protective action on the oxidation of titanium below 200°C. (TTT)

9372 ON THE CORROSION OF ALUMINIUM IN REACTOR, (III). Sueo Nomura (Japan Atomic Energy Res. Inst.). J. At. Energy Soc. Japan, 2: 603-10(1960). (In Japanese)

The effect of irradiation on the corrosion of 2S aluminum in flowing water was studied under the following conditions: 70 or 50°C, 3.0 or 1.6 m/sec flow rate, continuously demineralized or nondemineralized water, 600 kw-hr (at 40 kw for 15 hr) irradiation, and 75 hr total time. Under such conditions, the corrosion of 2S aluminum in in-pile loop water was found to be mostly affected by water quality, as well as the radiochemical changes of water rather than the radiation effects on aluminum specimens itself. The pile irradiation in JRR-1 was found to cause decreases in the corrosion of aluminum in continuously demineralized water, especially at higher flow rates of water, but it increased corrosion in nondemineralized water. These behaviors observed are explained on the basis of changes of oxidation potentials of water. The effects of temperature, positions of samples in loop, and volume of water per unit area of sample were also studied. (auth)

9373 THE OXIDATION AND CORROSION OF ZIRCONIUM AND ITS ALLOYS. V. MECHANISM OF OXIDE FILM GROWTH AND BREAKDOWN ON ZIRCONIUM AND ZIRCALOY-2. B. Cox (Atomic Energy Research Establishment, Harwell, Berks, England). J. Electrochem. Soc., 108: 24-30 (Jan. 1961).

Mechanisms for the film growth and breakdown on zirconium and Zircaloy-2 are discussed. Oxidation experiments were carried out on zirconium and Zircaloy-2 specimens at 300°C in 1-atm steam or in aqueous solutions. From the data, the following mechanism for oxide film growth and breakdown is proposed: The growth of the thin interference color film was found to obey a logarithmic growth law and probably is an example of Uhlig's thin film growth law as applied to metal oxidation. After the oxide film darkens and the interference colors disappear, the distribution of the inhomogeneous regions in the film due to impurities or alloying elements in the metal determines the subsequent behavior of the material. On this basis, the early failure of arc-melted zirconium and the breakaway of Zircaloy-2 below 400°C are explained. (D.L.C.)

9374 A STUDY OF THE FORMATION OF ANODIC OXIDE FILMS ON URANIUM. I. AN OPTICAL REFLECTIVITY METHOD FOR DETERMINING THE KINETICS OF FILM GROWTH. A. E. Stebbens and L. L. Shreir (Battersea Coll. of Tech., London, England). J. Electrochem. Soc., 108: 31-6 (Jan. 1961).

An optical reflectivity method is described which was used for investigating film growth during the anodic oxidation of uranium, and which may have a wider application in the field of anodic oxidation provided the optical constants of the film can be determined. Multiple-beam interferometry and polarized light methods were used to measure the optical constants of uranium and the anodically formed film. Using the former method, a value of 1.94 was obtained for the refractive index of the oxide. (auth)

9375 THE OXIDATION AND CORROSION OF ZIRCONIUM AND ITS ALLOYS. VI. THE MECHANISM OF THE FISSION FRAGMENT INDUCED CORROSION OF ZIRCALOY-2. B. Cox, K. Alcock, and F. W. Derrick (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Electrochem. Soc., 108: 129-33(Feb. 1961).

The results of investigations of the corrosion of Zircaloy-2 in high-temperature uranyl sulfate solutions under irradiation are reported. The kinetics of corrosion under these conditions is compared with the kinetics of corrosion in water and aqueous solutions out-of-pile, and, with the aid of electron microscopy, a mechanism for the irradiation enhanced corrosion is offered. (auth)

9376 COATINGS FOR COLUMBIUM. S. T. Wlodek (Union Carbide Metals Co., Niagara Falls, N. Y.). J. Electrochem. Soc., 108: 177-85(Feb. 1961).

The degree of protection from high-temperature oxidation which can be imparted to niobium by 10 different types of coatings was evaluated. The coatings were applied by Plasmarc, detonation gun, or gun-metallizing processes. Although chromium, stainless steel, and nichrome protected niobium from gross oxidation in the temperature range of 950 to 1150°C for hundreds of hours, chromium coatings allowed oxygen contamination of the niobium to occur as low as 950°C. A coating of LM-5 (Mo-Si-Cr-B-Al) prevented all reaction for about 1000 hr at 1150°C and 100 hr at 1500°C. The LM-5 coating behaved well under stress and exhibited some self-heating properties and thermal shock resistance. The latter two properties can be increased even further by introducing an alloy layer of the Nb-Ti-Cr-Al-Ni type between the LM-5 and the niobium article. This duplex coating retained the static exposure resistance and strain-rate insensitivity of the LM-5, while being able to withstand 30 water quenches from 1500°C before failure. These results indicate that satisfactory protection can be obtained for very simple niobium shapes. The coating of shapes large and complex enough to represent a commercially significant component is still an unsolved problem. (auth)

9377 METHOD OF CORROSION PROTECTION. M. Boisot. French Patent 1,185,241. Feb. 9, 1959.

Parts of homogeneous reactors such as vessels, fuel elements, or core channels are protected against corrosion by coating their surface with a thin layer (some microns) of evaporated carbon. The same method is said to be applicable to every type of machinery or product. (NPO)

9378 CORROSION REDUCTION. Sherman Greenberg, Robert D. Misch, and Westly E. Ruther. U. S. Patent 2,970,855. Feb. 7, 1961.

A method is described for reducing the corrosion of magnesium alloys by superheated water by adding about 0.7 ppm of sodium fluoride and then maintaining the pH at between 6 and 7 by additions from time to time of HF. (auth)

Fabrication

9379 (AD-239981) PROTECTION OF GRAPHITE BY IMPREGNATION. Quarterly Progress Report No. 1—February 7 to May 31, 1960. M. H. Ortner, S. J. Klach, and J. O. Gibson (Vitro Labs., West Orange, N. J.). July 13, 1960. 30p. Contract NOw 60-0167-c.

Exploratory experiments were performed on the fabrication, extrusion, and burning characteristics of titanium carbide electrodes of various compositions. Based upon these experiments, an electrode composition was chosen which gave a smooth burn in the vacuum chamber with little or no spalling. The maximum particle size of the product, determined by electron microscopy, was 0.3μ. Literature surveys were completed on methods of determining the pore structure of graphite and on prior work on graphite impregnation. Scoping experiments were begun on the dispersing characteristics of submicron powders, and on the impregnation of porous materials. Initial impregnation tests on porous SiC disks (1 in. diam by $\frac{1}{4}$ in. thick), using submicron Al_2O_3 particulates suspended in isopropanol, resulted in impregnation to a depth of approximately $\frac{1}{8}$ in. In tests using graphite specimens under the same conditions only surface pore impregnation was achieved. Increase of the cell voltage, the time, and the use of dispersing media of low viscosity and high dielectric constant failed to improve the depth of oxide penetration into the graphite matrix. (auth)

9380 (BM-RI-5588) PREPARATION OF HIGH-PURITY YTTRIUM BY METALLIC REDUCTION OF YTTRIUM TRICHLORIDE. F. E. Block, T. T. Campbell, R. E. Mussler, and G. B. Robidart (Bureau of Mines). 1960. 25p. Contract No. AT(11-1)-599.

An investigation was conducted to develop new methods for the preparation of high purity yttrium. Laboratory tests were made to devise methods for preparing high-purity anhydrous yttrium chloride, for reducing this compound with sodium or lithium, and for consolidating the resulting yttrium sponge into ingots. Lithium and sodium were found to be effective reductants; however, no comparative conclusion was made. (J.R.D.)

9381 (CF-60-4-121) A STUDY OF THE FORMING OF ZIRCALOY-2 HEMISPHERES BY POWER SPINNING. F. W. Cooke (Oak Ridge National Lab., Tenn.). Apr. 8, 1960. 95p.

Twelve Zircaloy-2 sheets, with thicknesses between 1/8- and 5/16-in., were formed into 15-in.-diameter hemispheres by power spinning in an effort to determine the feasibility of using such a method to fabricate core vessels for the Homogeneous Reactor Project (HRP). The fabrication of an entire hemisphere as a unit is of interest because it would reduce the number of welds required to form a vessel. This in turn, would reduce the chance of weld contamination and consequent impairment of corrosion resistance and mechanical properties. A number of difficulties such as laps and earing, were encountered but were overcome by modifications of the procedure. The maximum percentage of reduction in shell thickness was between 30 and 40%. The springback on the equatorial radius increased with thickness from 0.040 to 0.175 in., whereas the diametral ellipticity varies between 0.016 and 0.100 in. Three complete spheres were welded in a vacuum chamber using a technique developed by the vendor. Although the welding was not quite of HRP quality, it demonstrated that the spun shells could be assembled into vessels. (auth)

9382 (NAA-SR-Memo-5379) ZIRCALOY-2 FOR SRE REPLACEMENT MODERATOR CANS. R. K. Wagner Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 26, 1960. 9p.

The fabrication of Zircaloy-2 moderator cans is described. Results indicate that open-air heating of Zircaloy-2 had no effect on the mechanical properties or composition of the material. Single and multi-pass welding of Zircaloy-2 strip also produced no changes in the mechanical properties or chemical composition of this material. (J.R.D.)

9383 (NP-7901) FUSION WELDING OF BERYLLIUM. Progress Report No. 1 [for] May 1 to July 31, 1959. B. M. MacPherson and W. W. Beaver (Brush Beryllium Co., Cleveland). Aug. 15, 1959. 19p. Project No. 7351. Contract AF33(616)-6413.

The background for the work on fusion welding of beryllium is reviewed. The initial metallurgical examination of fused welds made with filler rods of QMV virgin beryllium is evaluated. (auth)

9384 (NP-9703) AEROSOL PREPARATION OF COMPOSITE METAL POWDERS FOR DISPERSION STRENGTHENING. Bimonthly Progress Report No. PR-N-311-7, July 16 to September 15, 1960. (Aeroprojects, Inc., West Chester, Penna.). 10p. Contract NOas 59-6247-c.

The aerosol coating of refractory particles with nickel was accomplished, in some preliminary experiments, through the decomposition of nickel carbonyl on the surface of dispersed alumina particles. The coated particles have not been evaluated, but on examination with an optical microscope the particles appear to be well coated. Further evaluation of the coated particles will be made. Additional experiments will be performed to optimize operating conditions for the coating of refractory particles. (auth)

9385 (ORNL-2965) PREPARATION OF HIGH-DENSITY OXIDES AND VIBRATORY COMPACTION IN FUEL TUBES. S. D. Clinton, O. C. Dean, W. S. Ernst, D. E. Ferguson, P. A. Haas, and K. H. McCorkle (Oak Ridge National Lab., Tenn.). Feb. 13, 1961. 19p. Contract W-7405-eng-26.

Initial experimental studies of simplified technologies for recycle of fuel and fertile materials to heterogeneous reactors have demonstrated chemical preparation of high-density oxides and vibratory compaction to give high densities in cladding tubes. Preparation of thorium or thorium-uranium sols followed by careful drying and calcination at 1200°C gave oxides with densities 98 to 99.4% of theoretical. Vibratory compaction by either pneumatic or electronic vibrators of mixed-sized fractions of powders gave ThO_2 or ThO_2-UO_2 densities in stainless-steel tubes up to 89% of theoretical. These procedures should decrease costs for direct fabrication and should permit remote preparation and compaction of oxide powders into fuel elements that have been assembled with empty pins. (auth)

9386 (TID-11535) THE CONVERSION OF EXTRUDED BERYLLIUM TUBING TO A CLOSE TOLERANCE BORE TUBE. Laboratory Report 1812. A. C. Hood and A. M. Bpunds (Superior Tube Co., Norristown, Penna.). Feb. 15, 1960. 133p. For Oak Ridge National Lab. Contract 13X-80025.

Includes Appendices: B. THE TROUBLE WITH BERYLLIUM. J. Sawkill. C. NITRIC FUME SCRUBBING. O. J. Jones and J. Sullivan (Tube Investments, Ltd. Technological Centre, Walsall, Staffs, England). Oct. 13, 1959.

Beryllium tubing is hot extruded from pre-sintered and machined billets to sizes from 0.025-in. OD by 0.030-in. wall to 2.0-in. OD by 0.250-in. wall. The extruded tubing is warm bore sized by pulling a mandrel through the tube, to attain close tolerances. A finished tube measures 0.375 ± 0.008-in. OD by 0.040 ± 0.001-in. ID. The bore sizing operation reduces the extruded tube yield by ~25%. The properties of the tubing were investigated by bending and internal hydrostatic proof testing at 1000 psi. Burst tests indicated that the tube will withstand 10,000 psi before failure where the surface was suitably polished chemically. Tubing texture studies revealed a preferred orientation with basal planes parallel to the longitudinal direction and situated radially out from the center of the tube; resulting in transverse properties lower than longitudinal properties. Metallographic studies revealed a precipitate in the supposedly pure metal which can be made to shift from the grain boundaries to the matrix by heat treatment. (B.O.G.)

9387 (AEC-tr-4384) CANNING BY THE DIFFUSION CAUSED BY A HEATED DIE. M. Gauthron (France. Commissariat à l'Énergie Atomique, Paris). Translated by M. S. Feldman from report CEA-1296. 1959. 3p.

A process is described for canning a uranium fuel with zirconium by passing the element through a die. The operation takes place at a temperature varying between 500 and 1000°C. The heating is obtained by passing low voltage electric current through the can. This process differs from the coextrusion process in that the uranium is not deformed. The uranium is therefore machined to the final dimensions before canning. (W.L.H.)

9388 (NP-tr-548) ELECTROLYTIC MACHINING OF HIGH-HARDNESS MATERIALS. A. Ya. Artamonov. Translated from Vestnik Mashinostroeniya No. 5, 61-5 (1959). 14p.

Methods are reported for electrolytic machining of very hard electrically conductive materials such as carbides, borides, nitrides, and silicides. The equipment used for these methods is described. (W.L.H.)

9389 MANUFACTURE OF REACTOR FUEL ELEMENTS BY APPLICATION OF THE EXTRUSION PRESS METHOD. Hans Pischel. Kerntechnik, 2: 366-9(Nov. 1960). (In German)

The materials used for fuel elements and for cladding them are first tabulated. The manufacture of natural-uranium fuel elements with an extrusion press with protection against oxidation being provided by a protective gas and salt is described. The coextrusion of various metals and the manufacture of plutonium fuel elements are also discussed. (tr-auth)

9390 COMPRESSION AND SINTERING TECHNOLOGY AND THEIR APPLICATIONS IN THE PREPARATION OF OXIDE REACTOR FUEL ELEMENTS. Hans Pischel. Kerntechnik, 2: 405-8(Dec. 1960). (In German)

After a brief introduction to compression techniques, the operation of sinter presses and the sintering process are described. The preparation of uranium dioxide fuel elements is discussed, and various compression and sintering methods are considered. Newly developed manufacturing methods are indicated. (tr-auth)

9391 GALVANIC COATINGS OF STRUCTURAL STEELS. M. A. Figel'man. Metalloved. i Termicheskaya Obrabotka Metal., No. 12, 21-5(1960). (In Russian)

Although Cr–Ni steels are not used very often with galvanic coatings, their austenitic character makes an investigation of their interaction with such coating of great interest. It was found that cadmium or cadmium + zinc coatings lower the strength of structural steels beyond 200°C; zinc coatings alone had a lesser effect. Sensitivity toward such interaction seemed to be only slightly dependent on the original properties of the base steel, or the conditions of the heat treatment. In certain cases chemical interaction was observed; the composite coating was found to be more strongly corrosive and harmful than the pure cadmium coatings, although actual diffusion of the coating into the steel could not be demonstrated metallographically. (TTT)

9392 ZIRCALOY WELDING TECHNIQUES DEVELOPED FOR PLUTONIUM RECYCLE PROGRAM UO_2 FUEL ELEMENT FABRICATION. L. E. Mills (General Electric Co., Richland, Wash.). Welding J. (N.Y.), 40: 141-51(Feb. 1961).

Metal-joining applications used to fabricate the UO_2 elements for the first Plutonium Recycle Test Reactor (PRTR) loading are discussed. Zircaloy-2, the only cladding material used in fabrication of these initial fuel elements, was readily welded with high reliability by resistance and arc welding processes. The major welding problem, gas absorption at elevated temperatures, was overcome by welding in a carefully controlled inert atmosphere or by completing the weld in a few milliseconds. Projection, seam, and magnetic-force butt welding processes were also used. A total of 259 individual welds was required to fabricate a 19-rod cluster fuel element. (M.C.G.)

9393 DIFFUSION BONDING OF ZIRCALOY PLATE-TYPE FUEL ELEMENTS. W. Lehrer and H. Schwartzbart (Illinois Inst. of Tech., Armour Research Foundation, Chicago). Welding J. (N.Y.), 40: 66-s-80-s(Feb. 1961).

A program on the diffusion bonding of plate type, compartmented ceramic-fuel, Zircaloy nuclear elements was completed. The fuel element consists essentially of a punched receptacle sheet of Zircaloy-2 bonded to two cover sheets of Zircaloy-2. The receptacle sheet forms the frames or compartments for the ceramic UO_2 fuel. By chemical displacement plating, the punched receptacle sheet was coated with a bonding agent such as copper, iron, or nickel. The element was assembled with the ceramic fuel platelets in their compartments, and the three sheets joined around their periphery by tungsten-inert-gas edge arc welding. The ceramic fuel platelets were coated with graphite prior to assembly to inhibit reaction between the UO_2 and the Zircaloy-2 bonding. The element was heated in helium atmosphere furnace to temperatures from 1600 to 1900°F, under positive pressures from 1 to 30 psi, and held from ¼ to 3½ hr. Bonding was achieved over the entire faying surface areas by formation of low-melting eutectics between the bonding agent and the Zircaloy, and diffusion of the eutectic into the Zircaloy. Based on the mechanical properties and corrosion resistance of bonded elements and on metallographic observations, copper served best as the diffusion bonding medium. The behavior of elements plated with iron was undependable, and voids generally formed in the bond. The effect of geometry on mechanical properties

of the elements is discussed in detail. A metallographic study of copper- and iron-plated disks on Zircaloy showed the effects of temperature, time, and heating and cooling rates on the interface reactions. (auth)

9394 MACHINING CHARACTERISTICS OF HIGH STRENGTH THERMAL RESISTANT MATERIALS. United States Air Force Machinability Report, 1960. Volume 4. Final Technical Engineering Report for December 22, 1958 to December 18, 1959. (Curtiss-Wright Corp. Wright Aeronautical Div., Wood-Ridge, N. J.). 1960. 181p. (AMC TR 60-7-532).

A study of the machining characteristics in turning, milling, drilling, and tapping was conducted on 25 high-strength thermal-resistant alloys. Relations are presented between tool life, cutting speed, feed, tool geometry, tool material, and cutting fluids. Alloys studied were of the following classes: martensitic low-alloy steels; hot-work die steels; austenitic, martensitic, and precipitation-hardening stainless steels; nickel-base and cobalt-base high-temperature alloys; and titanium alloys. The effects of grinding conditions are indicated with respect to their influence on wheel wear and surface finish for six typical high-strength thermal-resistant alloys: AM-350, 410 Stainless, A-286, Inconel 700, Udimet 500, and HS-25. Also the effect of grinding and milling variables on workpiece distortion and residual stress on ground and milled surfaces was determined on AISI 4340, AMS 6304, and Titanium (6A1-4V). Metal removal rates were over 35 times lower and tool life 100 times lower in milling 52 Rc hardness 4340 ultra-high-strength steel, as compared to milling aluminum. Grinding wheel speeds of approximately 6000 ft/min were required for reasonable grinding ratio (for minimum wheel wear); whereas speeds of about 2000 ft/min were necessary for minimum distortion and residual stresses in the workpiece. Increased requirements are described for precise control of rigidity, speeds, feeds, and tool geometry for machine tools to machine the high-strength thermal-resistant alloys. (auth)

9395 JOINING GRAPHITE PIECES. (to General Electric Co., Ltd.). French Patent 1,185,166. Feb. 9, 1959.

A method is given for joining graphite surfaces, which comprises induction heating the surfaces in a $Ni(CO)_4H_2$ atm. at 300 to 500°C in order to coat the surfaces with nickel and then followed by pressing them against each other at 1300°C. A separate nickel or zirconium bonding disk can be fixed between the coatings before pressing. The method can be applied for joining moderator blocks or for capping graphite-canned fuel elements with graphite. (NPO)

9396 PROTECTION OF GRAPHITE SURFACES. (to General Electric Co., Ltd.). French Patent 1,185,167. Feb. 9, 1959.

The interior and exterior surfaces of graphite bodies (moderator blocks and fuel-element cans) are protected against high-temperature corrosion (e.g., by CO_2 coolant) by coating with nickel. Single bodies are placed in an evacuated space; the space is filled with $Ni(CO)_4$, again evacuated, refilled with an inert gas, and finally heated to about 500°C. The whole moderator of a gas-cooled reactor can be treated by adding $Ni(CO)_4$ to the coolant while the moderator is cold and then bringing the reactor to operating temperature. The amount of nickel that may be brought into the core is restricted because of its high neutron absorption; hence it is proposed to apply nickel-coated graphite blocks only in certain parts of the core, e.g., in its center and at the channel outlets. (NPO)

9397 IMPROVEMENT IN METHODS OF MANUFACTURING REFRACTORY OBJECTS OF PURE ALUMINUM OXIDE. (to Commissariat à l'Énergie Atomique). French Patent 1,193,091. Apr. 27, 1959.

Al_2O_3 bricks, tubes, and other parts of 99.95% purity, weighing 1 to 10 kg and having excellent mechanical properties and a good thermal shock resistance, are manufactured by mixing Al_2O_3 powders of different grain size (e.g., 30% less than 5, 20% less than 160, and 30% 200 to 1200 microns), treating the mixture with HCl, and then rinsing, molding the powder, slowly drying the molded pieces, and finally sintering at 1000 to 1200°C, the temperature rise being 100°C/hr. The process can be applied to the manufacture of crucibles which find application in nuclear technology. (NPO)

9398 METHOD OF MANUFACTURE OF CARBON. (to United Kingdom Atomic Energy Authority). French Patent 1,195,625. May 19, 1959.

A method and apparatus for the manufacture of carbon are described in which a liquid hydrocarbon (e.g., a residual oil or a tar) is made to flow along an electrically heated surface, e.g., a carbon rod, at such a velocity that the flow of the boundary layer is laminar, as a result of which carbon is deposited on the surface. The temperature of the heating surface is gradually increased from 500 to 900°C in order to keep the surface of the carbon deposit at the carbonization temperature of 500°C. Alternatively the carbonization temperature can be increased to 1000°C or higher, in order to prevent cracking of the deposit due to thermal stresses. In this case boiling of the hydrocarbon must be avoided, either by proper choice of the hydrocarbon or by the application of pressure. The deposit is finally graphitized. The method can be applied for sheathing fuel slugs with carbon. (NPO)

9399 NEW METHOD AND APPARATUS FOR COATING BY CONTINUOUS OR SEMI-CONTINUOUS CASTING. (to Commissariat à l'Énergie Atomique). French Patent 1,203,912. Aug. 3, 1959.

A description is given of an apparatus for casting a protective coating around a fuel slug. (NPO)

9400 FUEL ELEMENTS FOR NUCLEAR REACTORS. (to C. A. Parsons & Co., Ltd.). French Patent 1,210,150. Sept. 28, 1959.

Helically finned fuel elements are described which are provided with longitudinal splitters, the part of each splitter that protrudes beyond the fins being undulated. (NPO)

9401 METHOD OF MANUFACTURING GRAPHITE BODIES. (to United Kingdom Atomic Energy Authority). French Patent 1,210,771. Oct. 5, 1959.

Graphite bodies having a density of 1.90 to 1.98 are manufactured by grinding very pure synthetic graphite until all particles have a diameter of below 40 μ and 80% have a diameter below 20 μ and then cold compacting the powder under a pressure of 3150 to 11,025 kg/cm^2. High-density dispersion fuel elements can be manufactured by incorporating up to 50 vol.% fissile or fertile material in the graphite powder; thus a compacted mixture containing 0.3 vol.% uranium and 0.6 vol.% thorium has a density of 2.4 at least. (NPO)

9402 METHOD FOR IMPROVING THE DISPERSABILITY OF SLURRY PARTICLES. (to U. S. Atomic Energy Commission). French Patent 1,217,372. Dec. 7, 1959.

The sedimentation velocity of aqueous metal oxide (particularly ThO_2) slurries is decreased by coating the oxide particles with an organic silicon compound, preferably a

mixture of $(CH_3)_2$ $SiCl_2$ and CH_3 $SiCl_3$, and then heating them at 600 to 1200°C. (NPO)

Properties and Structure

9403 (AFCRC-TN-60-559) INVESTIGATIONS OF RARE-EARTH OXIDE CATHODES. Second Scientific Report. G. B. Gaines (Battelle Memorial Inst., Columbus, Ohio). Mar. 1, 1960. 20p. Contract AF19(604)-5691, Project 4156, Task 46310.

The thermionic emission from a Gd_2O_3 sample was determined to be 1.6 amp-cm^{-2} at 1400°C. The calculated emission at 1500°C is 4.4 amp-cm^{-2}. A definite and reproducible break was found in the Richardson line at about 1175°C. Diodes employing a mixture of Gd and Nb oxides exhibited high emission values at low temperatures but tended to be unstable at temperatures above 1300°C. (For Report No. 1, see Report AFCRC-TN-60-108.) (auth)

9404 (CVNA-49) EVALUATION OF ALUMINUM ALLOYS FOR APPLICATION AS A PRESSURE TUBE MATERIAL IN THE CAROLINAS-VIRGINIA TUBE REACTOR. G. G. Lessmann (Carolinas Virginia Nuclear Power Associates, Inc., Charlotte, N. C.). Feb. 1, 1960. 31p.

A survey of aluminum alloys for application as a pressure tube material in the Carolinas-Virginia Tube Reactor was conducted. Applicable aluminum alloys were considered with regard to their fabricability, material properties, and their ability to meet the CVTR core environmental requirements. (auth)

9405 (DMIC-140) PHYSICAL AND MECHANICAL PROPERTIES OF COMMERCIAL MOLYBDENUM-BASE ALLOYS. J. A. Houck (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Nov. 30, 1960. 177p. Contract AF18(600)-1375. (PB-151099).

A compilation of the more important physical and mechanical properties of molybdenum and commercial molybdenum-base alloys is presented. Included among the alloys are Mo–0.5Ti, Mo–0.5Zr, Mo–0.5Ti–0.08Zr (TZM), Mo–0.05Zr, Mo–30W, Mo–50W, and Mo–1.25Ti–0.5Zr–0.15C (TZC). (auth)

9406 (DMIC-142) ENVIRONMENTAL FACTORS INFLUENCING METALS APPLICATIONS IN SPACE VEHICLES. J. M. Allen (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Dec. 1, 1960. 48p. Contract AF18(600)-1375. (PB-151101).

The specialized environments that are imposed on metals and the possible consequences of these environments are described. In general, the specialized environments are identified with the natural environment of space, the entry into an atmosphere, or the power-conversion system utilized by the vehicle. (auth)

9407 (DMIC-Memo-79) PRELIMINARY DESIGN INFORMATION ON RECRYSTALLIZED Mo–0.5Ti ALLOY FOR AIRCRAFT AND MISSILES. W. P. Achbach and R. J. Favor (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Jan. 16, 1961. 14p. Contract AF33(616)-6410. (PB-161229).

Data on the room-temperature mechanical and physical properties of recrystallized Mo–0.5Ti alloy are tabulated, and curves representing the effects of temperature on the compressive and tensile properties of this alloy are presented. (J.R.D.)

9408 (DMIC-Memo-80) PHYSICAL AND MECHANICAL PROPERTIES OF SOME HIGH-STRENGTH FINE WIRES. D. A. Roberts, comp. (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Jan. 20, 1961. 23p. (PB-161230).

The available data are presented on the mechanical and physical properties of some high-strength fine wires. Such wires are of increasing interest as possible materials of construction in rocket-motor cases, pressure vessels, aircraft cable, and high-temperature parachute cloth. The data cover wires of 0.010-in. diameter or smaller having tensile strengths in excess of 250,000 psi. (auth)

9409 (GA-1479) MARITIME GAS-COOLED REACTOR PROGRAM. X-RAY STUDY OF THE TERNARY SYSTEM U–Al–O. L. J. Dykstra (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 19, 1960. 23p. Contract AT(04-3)-187.

An x-ray-diffraction study was made of the ternary system U–Al–O, and the phase-equilibrium diagram was found to be very simple. No phases were observed which did not occur in the three related binaries. Furthermore no evidence was found of solid solutions between Al_2O_3 and uranium oxides. (auth)

9410 (IS-240) TENSILE PROPERTIES OF YTTRIUM-TITANIUM AND YTTRIUM-ZIRCONIUM ALLOYS. D. W. Bare, E. D. Gibson, and O. N. Carlson (Ames Lab., Ames, Iowa). Dec. 1960. 19p. Contract W-7405-eng-82.

Complete series of yttrium-titanium and yttrium-zirconium alloys was tested in tension at room temperature. Ultimate tensile strength, yield strength, and reduction in area data are reported for the alloys. Yield point phenomena were encountered in both alloy systems. (auth)

9411 (LR-12954) FATIGUE TESTS OF SOME HOT PRESSED BERYLLIUM. R. L. Lowe (Lockheed Aircraft Corp., Burbank, Calif.). Mar. 27, 1958. Revised Oct. 6, 1959. 25p.

Results of fatigue tests completed on specimens that were machined from QMV hot-pressed 1050 beryllium block at frequencies up to 10,000,000 cycles are reported. Additional fatigue tests performed on QMV hot-pressed 1050 beryllium block extended to 100,000,000 cycles are included. Reported also are the results of fatigue tests of $\frac{1}{8}$-in. beryllium sheet in which testing was carried out to 10,000,000 cycles. (auth)

9412 (NAA-SR-5684) DISLOCATION INTERACTION AND THE HIGH TEMPERATURE MECHANICAL PROPERTIES OF MgO CRYSTALS. Roger Chang (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1960. 21p. Contract AT(11-1)-GEN-8.

The high-temperature yield stress and anelastic properties of MgO crystals were measured. The results are interpreted according to a dislocation interaction mechanism where a moving dislocation is impeded by an atmosphere of defects. The stress required to move a dislocation is determined by the concentration of defects present in the atmosphere, which in turn is determined by the magnitude of interaction energy between defects and the dislocation. Both the yield stress data and internal friction data yield a binding energy between the defect, presumably a positive-ion vacancy, and a dislocation of approximately 0.3 ev. (auth)

9413 (NAA-SR-Memo-5716) MECHANICAL PROPERTIES OF ALUMINUM ALLOYS AT VARIOUS TEMPERATURES. D. E. Ellis (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 20, 1960. 10p.

Studies were made to determine the mechanical properties of aluminum alloys that would be applicable to SNAP-2

radiator-condenser design. The mechanical properties of 6061-T6, 2024-T3, 1100-0, and Alcoa No. 23 braze sheet were established, and the results are reported. (W.L.H.)

9414 (NASA-TN-D-644) A STUDY OF THE OXIDATION OF MATERIALS IN AN ARC-IMAGE FURNACE. R. Gale Wilson, Roger W. Peters, and Arthur J. McEvily, Jr. (National Aeronautics and Space Administration, Washington, D. C.). January 1961. 26p.

The rates of weight loss for silicon carbide, graphite, nylon, Bakelite, Fiberglas phenolic, and ammonium chloride were investigated as a function of oxygen concentration and radiant heat flux. The investigation was made with an arc-image furnace which provides radiant heat fluxes in the range of 100 to 1000 Btu/sq ft/sec. In the upper half of this range the rate-controlling process for materials that oxidize was found to be the diffusion rate of oxygen to the specimen surface. (auth)

9415 (NMI-1218) STABILITY OF THE HIGH TEMPERATURE BETA PHASE IN BERYLLIUM AND BERYLLIUM ALLOYS. S. H. Gelles and J. J. Pickett (Nuclear Metals, Inc., Concord, Mass.). Oct. 10, 1960. 44p. Contract AT(30-1)-1565.

Binary alloys of beryllium with cerium, chromium, copper, iron, lanthanum, nickel, niobium, palladium, platinum, silicon, silver, vanadium, and zirconium and the ternary system beryllium-nickel-palladium were investigated by differential thermal analyses. As a result of this investigation, the beryllium-rich portion of the beryllium-nickel phase diagram was established. Tentative phase diagrams of the beryllium-rich portions of the chromium-iron-silver- and silicon-beryllium alloys are presented. Of all the elements investigated, nickel appears to have the greatest stabilizing effect on this body-centered cubic phase. The transformation temperature from β to α was found to decrease in this system from 1265°C for pure beryllium to 1065°C for Be–8 at.% Ni alloy. The latter alloy was used for investigation of the crystal structure of the high temperature phase. This was found to have a body-centered cubic lattice, the alloy having a lattice parameter $a_0 =$ 2.60 Å. Some work was done in attempting to retain the β phase in a Be–8 at.% Ni alloy by quenching. (auth)

9416 (NP-9355) ELASTIC PROPERTIES RESEARCH. Second Progress Report [for] April 1, 1960–September 30, 1960. J. R. Lytton, J. A. Hren, K. T. Kamber, G. A. Coquin, and O. D. Sherby (Stanford Univ., Calif.). 26p. Contract AF33(616)-6789.

The major components of the modulus measuring equipment developed for elastic properties research were designed and built. Dynamic elastic modulus measurements were made on oriented Fe–3.2% Si transformer sheet. The effect of order–disorder on Young's modulus and creep of beta brass was investigated. Factors controlling the ΔE effect in pure and commercially pure nickel are being investigated. The role of grain-boundary relaxation on the elastic properties of polycrystalline aggregates was investigated. The effect of a magnetic field on the plastic properties of nickel is being investigated. (W.L.H.)

9417 (NP-9723) BEHAVIOR OF METALS IN ULTRA-HIGH VACUUM. John L. Ham (National Research Corp., Cambridge, Mass.). Aug. 1, 1960. 20p.

Recent experimental work indicated that surface properties can have an important influence on the behavior of materials in space. In cases where the surface phenomena may be important in determining the suitability of materials for prolonged exposure in space, investigations should be conducted at pressures less than 10^{-9} mm Hg to prevent the reformation of a protective surface layer from residual atmosphere during the course of the experiments. Theoretical maximum rates of formation and removal of oxide films on metals are calculated. Surface loss due to metal evaporation reaches 0.1 mm per year for Cd at 95°C, for Zn at 147°C, and for Mg at 198°C. Temperatures for dissociation of 100-A thick layers of oxide in a year on Ag, Cu, Fe, and Mo are approximately –127, 510, 1040, and 1050°C, respectively. Temperatures for diffusion inward of 100-A thick layers of oxide in a year on Ti or Zr are about 300°C. Temperatures for carbon reduction of 100-A thick oxide layers on Fe and Mo containing carbon are surprisingly low (<200°C). Estimates are made concerning the metals Al, Pb, Ni, Co, Cr, and W. Carbon reduction is probably important with respect to Cr, Co, Ni, and W. Oxide evaporation is important in the case of Ni, Cr, and possibly Co. Metal evaporation and possible consequent mechanical oxide removal may be important with respect to Al, Mg, Zn, Cd, Pb, Cr, and Fe. (auth)

9418 (NP-9786) SULFUR HEXAFLUORIDE AS A FUEL FOR IONIC PROPULSION. Progress Report No. 1. G. G. Cloutier (RCA Victor Co., Ltd. Research Labs., Montreal). Nov. 8, 1960. 24p. Contract AF33(616)-7437.

The basic processes for the formation of negative ions, the general characteristics of a negative ion source, and the properties of a sulfur hexafluoride as a potential fuel for ionic propulsion are discussed. The experimental arrangement and the tests to be conducted on two types of negative ion sources are described. (auth)

9419 (NP-9791) CARBONIZATION OF PLASTICS AND REFRACTORY MATERIALS RESEARCH PROGRAM. Quarterly Progress Report No. 4, October 1, 1960 to December 31, 1960. J. A. Coffman, K. L. Coulson, and G. M. Kibler (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Dec. 31, 1960. 89p. Contract AF33 (616)-6841.

Progress is reported in studies on the rate and mechanism of plastics carbonization, vapor pressures of refractories, and spectral normal emissivities of refractory materials. Included are results of studies of selected properties of the carbonaceous residue from a phenolic resin and results from analyses of vapor species produced from carbonizing a Tonox-cured epoxy resin. Changes in composition with temperature of carbonization are discussed. Data are given on the resistivity of carbonized phenolic specimens as influenced by temperature and extent of carbonization. A metapolyphenylene resin of suitable molecular weight was synthesized for future carbonization experiments. Vapor-pressure measurements on ZrC were completed. Evidence is given for concluding that evaporation from stoichiometric ZrC is congruent. Vapor pressure vs. temperature relations for Zr and C over ZrC are given. Agreement of thermodynamic property data deduced from the measured vapor pressures with values calculated from low-temperature thermodynamic functions is shown. Results of work on the evaporation of WC are given. Emissivity measurements were concluded on siliconized graphite. Tantalum and molybdenum were also studied, and spectral-emissivity values from 1 to 6 μ are given at various temperatures for these materials. A theoretical study of the rate of vaporization of low-sticking coefficient molecules from porous solids and a description of the methods of chemical analysis of free and total carbon in refractory carbides are included. (auth)

9420 (NYO-4808) KINETICS OF REACTIONS BETWEEN LIQUID METALS AND LIQUID SALTS. Progress

Report Covering Period March 1, 1960–December 30, 1960. Thomas B. King (Massachusetts Inst. of Tech., Cambridge). Jan. 17, 1961. 10p. Contract AT(30-1)-1985.

Results are summarized for studies of exchange reactions between cadmium, lead, tin, and zinc alloys, and bismuth and silver chlorides. Direct rate measurements for systems involving rate control by phase boundary reactions were studied using alloys of aluminum with copper or silver, and silicates of the alkali or alkaline earth groups, for the reaction: $Si^{4+} + \frac{4}{3}\,\underline{Al} = \underline{Si} + \frac{4}{3}\,Al^{3+}$. The results indicate that the virtual maximum rates of transport steps, aluminum and silicon in the metal and alumina and silica in the silicate, are much higher than the observed reaction rate. (For preceding period see NYO-4806.) (B.O.G.)

9421 (NYO-7061) SMALL ANGLE SCATTERING IN GOLD-NICKEL ALLOYS. Report No. 39. G. Nagorsen and B. L. Averbach (Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy). Dec. 16, 1960. 6p. Contract AT(30-1)-1002, Scope II.

The small-angle X-ray scattering in Au–Ni solid solutions is shown to arise from double Bragg reflections and to be unrelated to critical scattering associated with fluctuations in short-range order. (auth)

9422 (ORNL-1386) THERMAL CYCLING OF URANIUM. Nathaniel Stetson and Melbourne L. Winton (Oak Ridge National Lab., Tenn.). Aug. 1952. Decl. Feb. 24, 1960. 41p. Contract W-7405-eng-26.

An apparatus was designed and used successfully for the thermal cycling of test rods of various metals. Heating is obtained by passing an electric current through the rod. The equipment provides a wide range of cycling rates and a choice of coolants. Thermal cycling of water-cooled α-rolled uranium rods at 8 cps with a 20% duty cycle and an average power input of 15 kw/in.^{3} is described. Stress failure in water-cooled uranium rods subjected to an average power input exceeding 25 kw/in.^{3} at 400 cpm and 33% duty cycle is reported. (J.R.D.)

9423 (ORO-364) STUDY OF PHASE RELATIONSHIPS IN THE U–C–O SYSTEM. Progress Report. R. F. Stoops and J. V. Hamme (North Caroline State Coll., Raleigh). Dec. 31, 1960. 13p. Contract AT-(40-1)-2663

Various combinations of U, C, UC, UO_2, and U_3O_8 were reacted at 1500 and 1800°C in carbon monoxide or argon atmosphere, or in vacuum. Best results were obtained when materials were reacted in an argon atmosphere at 1800°C. Under these conditions, two U(C,O) phases occurred simultaneously in some specimens. Similar occurrences observed in other systems were indicative of non-equilibrium conditions. The lattice parameters of these two phases indicated that their compositions were approximately $U(C_{0.7}, O_{0.3})$ and $U(C_{0.3}, O_{0.7})$. The latter contained more oxygen than any such phase previously reported, except that UO was reported in very thin films on metals. (auth)

9424 (SCL-T-356) STUDY OF THE DEFECTS IN THIN REPLICA FILMS OF ALUMINA IN RELATION TO THE STRUCTURE OF ALUMINUM AND ITS ALLOYS. P. Bussy. Translated by Marcel I. Weinreich from Rev. mét., 50: 629-34(1953). 13p.

A new structure which appears at extremely high magnification, is described in replicas of pure aluminum, technical-grade aluminum, aluminum-copper-4% alloys, and aluminum-zinc-8 and -12% alloys. It is shown that this particular structure is closely related to the structure of the metal under study and is not a structure that might be characteristic of oxide coating crystals. This structure affects most often the aspect of tenuous grooves (streaks) which appear only on certain preferred grains. In other cases, this structure appears in the form of regular polygonal contours or in rare cases the grooves have spacings up to 2500 A. The influence of dissolved elements and cooling rate is discussed along with defects in groove arrangement. (J.R.D.)

9425 (TID-5802) FLOW ORIENTATION AND FRACTURE STRENGTH OF A MODEL LINEAR HARD POLYMER SOLID. Technical Report No. 3. C. C. Hsiao (Minnesota. Univ., Minneapolis). July 1959. 14p. Contract AT(11-1)-532.

A mathematical analysis is given to describe the effect of prior large flow orientation on the variation of the fracture strength of a model linear hard polymer solid. For the simple state of uniaxial orientation, the fracture strength in the direction of orientation and that perpendicular to the direction of orientation are evaluated as functions of the strain change and the strength of the unoriented material. The results indicate an increase of strength in the direction of orientation and a decrease of strength perpendicular to the direction of orientation as the degree of orientation increases. (auth)

9426 (TID-5803) STRETCH ORIENTATION AND TENSILE STRENGTH OF POLYSTYRENE AND POLYETHYLENE SOLIDS. Technical Report No. 4. C. C. Hsiao (Minnesota. Univ., Minneapolis). July 1959. 17p. Contract AT(11-1)-532.

For samples of oriented amorphous polystyrene and partial crystalline polyethylene the fracture strengths for different degrees of uniaxial flow orientation are determined and are found to agree fairly well with certain theoretical predictions. For hard polymers the effect of uniaxial orientation upon the tensile breaking stress of a simplified model solid is discussed. The fracture strength in any direction of this model material may be determined by obtaining the expectation of the strength components of a system of perfectly oriented model elements in that direction. (auth)

9427 (TID-5805) ON TIME DEPENDENT TENSILE STRENGTH OF SOLID BODIES. Technical Report No. 6. C. C. Hsiao (Minnesota. Univ., Minneapolis). Aug. 1959. 15p. Contract AT(11-1)-532.

Study of the time-dependent mechanical strength of solids reveals the existence of basic relation. For any constant values of strain, the tensile strength is linearly related with the logarithm of strain rate. From this general relation, both the time-dependent fracture strength and the creep-rate stress relations may be obtained as special cases. (auth)

9428 (TID-5806) EFFECT OF ORIENTATION ON STRENGTH OF A MODEL SOLID. Technical Report No. 7. J. E. Osborn and C. C. Hsiao (Minnesota. Univ., Minneapolis). Sept. 1959. 9p. Contract AT(11-1)-532.

A mathematical analysis is given to describe the effect of orientation on the variation of the mechanical strength of a model linear molecular solid. For the simple state of uniaxial orientation, the fracture strength in the direction of orientation is evaluated as a function of the degree of orientation in terms of the orientation strain and the strength of the unoriented solid. Assuming the fracture strain remains constant, the maximum fracture strength obtainable for a perfectly oriented solid is found to be six times that of the solid without preferred orientation. (auth)

9429 (TID-5807) ON TENSILE STRENGTH OF A BIAXIALLY ORIENTED MODEL SOLID. Technical Report

No. 8. C. C. Hsiao and J. E. Osborn (Minnesota. Univ., Minneapolis). Oct. 1959. 7p. Contract AT(11-1)-532.

A mathematical analysis is given to describe the effect of biaxial orientation on the tensile strength of a model solid. The fracture stress for any degree of biaxial orientation is evaluated as a function of orientation strain and the unoriented strength. Some available experimental data are found to agree fairly well with the predicted fracture surface. (auth)

9430 (TID-5808) THEORY OF MECHANICAL STRENGTH OF A UNIAXIALLY ORIENTED MODEL SOLID. Technical Report No. 9. C. C. Hsiao, J. E. Osborn, and D. B. Rozendal (Minnesota. Univ., Minneapolis). Nov. 1959. 9p. Contract AT(11-1)-532.

A mathematical theory of mechanical breakdown of a uniaxially oriented microscopic model solid is considered and generalized. It seems that a more realistic stress-strain law can be formulated on the basis of considering the model under orientation. Two strain quantities in the formulation are found to be separable, one is a small strain and the other an orientation strain. The small strain, which governs the volume change as well as the fracture mechanism, may be regarded as more or less linearly related with the strength of the solid for any particular state of orientation; whereas the orientation strain is essentially the total strain which identifies the orientation and thus the anisotropy of the solid. (auth)

9431 (TID-6920) AN INVESTIGATION OF SOME RARE EARTH BORON, CARBON, NITROGEN AND RELATED SYSTEMS AT ELEVATED TEMPERATURES. Technical Progress Report. (Michigan State Univ., East Lansing. Dept. of Chemistry). 8p. Contract AT(11-1)-716.

Research was performed in the following areas: the samarium–boron system; the lanthanum–selenium system; the preparation of rare-earth monotellurides, and an illucidation of their crystal structure; the cerium-nitrogen system; and the reaction between rare-earth selenides and molybdenum. (W.L.H.)

9432 (TID-6938) DIFFUSIONLESS PHASE CHANGES IN NON-FERROUS METALS AND ALLOYS. Technical Progress Report. T. A. Read, D. S. Lieberman, A. H. Ahmed, W. Class, H. Fara, D. Gupta, K. Mukherjee, J. A. Mullendore, and R. L. Patterson (Illinois. Univ., Urbana.). July 15, 1960. 121p. Project No. 15. Contract No. AT (11-1)-67.

Results of a study of Au-Cd alloys near the equiatomic composition are presented. Theoretical aspects are discussed and experimental procedures are described. Transformations that occur by the movement of interfaces through large volumes below the M_F temperature are discussed. Isothermal transformation above the M_s temperature is also investigated, along with transformations between the M_s and M_F temperatures and other structural aspects. The work provides evidence that the diffusionless phase transformations in Au-Cd alloys within 1% of stoichiometry are isothermal although they had originally been observed under continuous cooling conditions. In other work the aging effects in quenched Au-Cd alloys of a 49 at.% cadmium concentration were investigated. It was found that quenched specimens held at a constant temperature were observed to undergo an aging process that is characterized by an increase in lattice parameter and a decrease in length. Associated with this process is an increase in integrated line breadth, which is observed only in the period of time when the relaxation process is going on. Observed effects are also included for alloys of 47.5 at.% cadmium. (For preceding period see AECU 4394.) (J.R.D.)

9433 (TID-11052) LOW-TEMPERATURE ELASTIC CONSTANTS OF MAGNESIUM ALLOYS. Stephen Eros (Case Inst. of Tech., Cleveland). Dec. 1959. 41p. Contract AT(11-1)-623.

The elastic constants of a series of magnesium alloy single crystals were measured at liquid nitrogen and liquid helium temperatures, as well as at 25°C. These alloys covered an electron/atom range of 1.996 to 2.020. The purpose was to look for effects which are predicted to be associated with the initiation of a new electronic overlap, and which can only be observed at low temperatures. In particular, the onset of such an overlap should be manifested by a sudden drop in the observed values of $C = C_{11} + C_{12} + 2C_{33} - 4C_{13}$ at an beyond that value of e/a for which the overlap occurs. No such drop is observed in the range covered. This fact, and the directness and simplicity of the rigid band model in predicting such behavior, is considered strong evidence that no new overlap has been initiated in the range investigated. (auth)

9434 (TID-11644) HIGH-RESOLUTION INFRARED SPECTRA OF TRITIUM- AND DEUTERIUM-SUBSTITUTED MOLECULES. Annual Report for Period April 1, 1960 to December 31, 1960. H. H. Nielsen and K. Narahari Rao (Ohio State Univ. Research Foundation, Columbus). Dec. 23, 1960. 27p. Contract AT(11-1)-882.

Results of experimental work on the vibration-rotation bands of CT_4 at 5 to 15 μ are included with a discussion of the Q branchlike structure at 868 and 867 cm^{-1} and the ν_3 band of CT_4. Data on bands of the $DC^{12}N$ molecule in the region of 8.85 μ are also given. (J.R.D.)

9435 (UCRL-6175) THE SYSTEM H_2O-NaCl AT ELEVATED TEMPERATURES AND PRESSURES. S. Sourirajan and G. C. Kennedy (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 1960. 45p. Contract W-7405-eng-48.

The system H_2O-NaCl was studied at pressures to 1240 bars and temperatures of 250 to 700°C. The temperature and pressure of the gas-solid-liquid boundary curve were determined, and the solubility of solid NaCl in steam up to saturation pressures was measured. The composition of coexisting gases and liquids at pressures above the melting pressure and below the critical pressure was determined for isotherms from 350 to 700°C. The critical composition and pressure for various isotherms were determined. The NaCl concentration of saline hot springs is not inconsistent with the postulate that the sodium chloride was transported from the magmatic hearth in gaseous H_2O. (auth)

9436 (WADD-TR-60-56(Pt.II)) A COMPENDIUM OF THE PROPERTIES OF MATERIALS AT LOW TEMPERATURE (PHASE I). PART II. PROPERTIES OF SOLIDS. Period covered: January 1958 to March 1959. Victor J. Johnson, ed. (National Bureau of Standards. Cryogenic Engineering Lab., Boulder, Colo.). Aug. 1960. 333p. Contract AF33(616)-58-4.

Thermal expansion, thermal conductivity, and specific heat and enthalpy are given for a number of solids of interest in cryogenic engineering. Data sheets, primarily in graphic form, are presented from "best values" of data collected. The source of the material used, other references, and tables of selected values with appropriate comments are furnished with each data sheet to document the data presented. Conversion tables are also included. (auth)

9437 (WADD-TR-60-340) VOID FORMATION AND GRAIN BOUNDARY SLIDING IN ALUMINUM–MAGNESIUM

SOLID SOLUTION ALLOYS. Arthur W. Mullendore and Nicholas J. Grant (Massachusetts Inst. of Tech., Cambridge). Sept. 1960. 38p. Contract AF33(616)-5926. Project No. 7351.

Void formation and growth during creep were observed in aluminum–1.92% magnesium and aluminum–5.10% magnesium as a function of temperature, stress, and time. The origin of voids is related to the development of an irregular (serrated) grain boundary and to grain boundary sliding. Grain boundary sliding is shown to result largely from crystal slip crossing the grain boundary. (auth)

9438 (Y-1307) THE EFFECT OF CASTING VARIABLES AND HEAT TREATMENT ON THE TENSILE PROPERTIES OF LEAD-0.02 TO 0.10 WEIGHT PER CENT CALCIUM ALLOY. Allen B. Townsend (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Feb. 25, 1960. 24p. Contract W-7405-eng-26.

Some of the controllable variables have been investigated in casting of lead alloys having 0.06 to 0.09 wt.% Ca. The alloy has been found to respond to solution heat-treatment, room-temperature precipitation hardening, and accelerated hardening at 100°C. Tensile strengths to 7000 psi have been obtained. (auth)

9439 (AEC-tr-4343) ON CARBIDE SYSTEMS CONTAINING HAFNIUM CARBIDE. E. Rudy, H. Nowotny, F. Benesovsky, R. Kieffer, and A. Neckel (Institute for Inorganic and Physical Chemistry, Univ. of Vienna). Translated by Translations, New York, from Monatsh. Chem., 91: 176-87(1960). 10p.

The systems HfC–TiC–VC, HfC–NbC–VC, HfC–TaC–VC, HfC–UC–NbC, Hf–UC–TaC, and HfC–ZrC–UC were studied. It was found that zirconium and hafnium are not entirely homologous in this type of compound. Contrary to the relationship in the ZrC–UC system (completely soluble), the HfC–UC system shows a miscibility gap at 2000°C. The influence of third carbide additions on these systems was examined. Data on lattice constants are presented graphically. (J.R.D.)

9440 (AEC-tr-4362) HEATS OF FORMATION OF NIOBIUM OXIDES AND CARBIDES. F. G. Kusenko and P. V. Gel'd. Translated from Izvest. Akad. Nauk S.S.S.R., Sibir. Otdel., No. 2, 46-52(1960). 8p.

The heats of combustion of Nb oxides, carbides, and hydrides and Nb metal were determined. As a check, the values for graphite and acetylene were also determined. The heats of formation were then calculated from these data. (T.R.H.)

9441 (AEC-tr-4446) RECRYSTALLIZATION OF COLD-ROLLED U. G. Ya. Sergeev (Sergeyev), V. V. Titova, and L. I. Kolobneva (Kolobnyeva). Translated by S. J. Rothman (Argonne National Lab.) from Atomnaya Energ., 9: 104-9(1960). 12p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract No. 3116.

9442 (NP-tr-545) RESEARCH OF CERMET BASED ON ZrO_2–Cr. L. P. Kachalova and A. I. Avgustinik. Translated from Izvest. Vysshykh Ucheb. Zavedenii, Khim. i Khim. Tekhnol., No. 5, 70-5(1958). 10p.

Zirconium oxide in a mixture with powdered chromium can be used for making a cermet that is high in mechanical strength and has considerable resistance to heat. In microscope and x-ray work on specimens of the cermet no other forms were found other than the two phases of monoclinic ZrO_2 and metallic chromium. Tests of the cermet in molten brass and steel showed it to be heat resistant up to 20 cycles. The Cr–ZrO_2 cermet is not wetted by molten metals and its solubility in molten metal depends on its composition. (W.L.H.)

9443 (NP-tr-546) EXAMINATION OF MICROPOROSITY IN CERTAIN METALS, ALLOYS, AND POWDERS OF OXIDES BY THE METHOD OF SMALL-ANGLE SCATTERING OF X-RAYS. S. M. Astrakhantsev and Ya. S. Umanskii (Umanskiy). Translated from Izvest. Vysshikh Ucheb. Zavedenii, Tsvetnaya Met., No. 6, 115-25(1958).

The processes involved in the liquidation of micropores during hardening of several refractory oxides and in appearance of pores in electrically deposited nickel during annealing, as well as during the elimination of zinc from brass, were studied by small-angle x-ray scattering. Powders of Al_2O_3, BeO, and MgO show a considerable microporosity, which is eliminated during the calcination, accompanied by redistribution of pores according to size. The basic cause for porosity of electrically deposited metals consists in the relaxation of distortions of the crystalline lattice. It was established that the formation of porosity has the diffusion character also in the early stages of elimination of the volatile component. Only the formation of pores without any noticeable coagulation is observed at low temperature. (W.L.H.)

9444 THE CRYSTAL STRUCTURE OF Y_5Si_3 AND Y_5Ge_3. Erwin Parthé (Massachusetts Inst. of Tech., Cambridge). Acta Cryst., 13: 868-71(Nov. 10, 1960). (In English)

The crystal structures of Y_5Si_3 and Y_5Ge_3 were studied by rotation and Debye-Scherrer powder photographs. Both compounds crystallize in the $D8_8$ structure type. Y_5Si_3 has the lattice constants $a = 8.40_3$ and $c = 6.30_3$ Å. The dimensions of Y_5Ge_3 are $a = 8.47_1$ and $c = 6.35_0$ Å. Both compounds have an unusually large c/a ratio. (auth)

9445 THE CRYSTAL STRUCTURE OF $PuNi_4$. Don T. Cromer and Allen C. Larson (Los Alamos Scientific Lab., N. Mex.). Acta Cryst., 13: 909-12(Nov. 10, 1960). (In English)

The structure of $PuNi_4$ was determined by single-crystal x-ray methods. The unit cell is monoclinic, space group C2/m with a = 4.87, b = 8.46, and c = 10.27 Å and $\beta = 100°$. There are six formula units per unit cell. Two of the six plutonium atoms have a coordination essentially identical to that of the plutonium in $PuNi_5$. The other plutonium atoms have a coordination somewhat similar to the plutonium in $PuNi_5$. The $PuNi_4$ structure can be obtained by removing the nickel atoms at $z = \frac{1}{2}$ from every third unit cell of $PuNi_5$ and by slightly shifting the remaining atoms. (auth)

9446 THE CRYSTAL STRUCTURE OF $CeCu_6$. Don T. Cromer, Allen C. Larson, and R. B. Roof, Jr. (Los Alamos Scientific Lab., N. Mex.). Acta Cryst., 13: 913-18(Nov. 10, 1960). (In English).

The crystal structure of $CeCu_6$ was determined by single-crystal x-ray-diffraction methods. The crystal system is orthorhombic with: a = 8.112, b = 5.102, and c = 10.162 Å. The unit cell contains four formula units and the probable space group is Pnma. Three-dimensional x-ray data were obtained by two different counter techniques and the results are compared. The trial structure was determined by application of the sign relation $S_H = S_K \cdot S_{H+K}$ to the h0l zone. The final structure was obtained by a least-squares refinement with anisotropic temperature factors included. The structure contains typical metallic bonds. There are no Ce–Ce contacts and each cerium atom is surrounded by 19 copper atoms in a manner quite similar to the surroundings of calcium in the $CaCu_5$ structure. The average Ce–Cu distance is 3.146 Å. The Cu–Cu distances are in reasonable agreement with those found in copper metal. (auth)

9447 THE PEROVSKITE-TYPE STRUCTURES OF $DyAlO_3$, $DyFeO_3$, AND SOME RELATED LANTHANON MIXED OXIDES. J. A. W. Dalziel and A. J. E. Welch (Imperial College, London, Eng.). Acta Cryst., 13: 956-8 (Nov. 10, 1960).

The perovskite type structures of selected lanthanon-mixed oxides ($LnBO_3$) were investigated to determine the factors which influence their distortion. Lanthanum, neodymium, gadolinium, and dysprosium, which have a suitable range of ionic radii, were chosen for the tripositive Ln ions. Aluminum, iron, and gallium, which have tripositive ions with an inert gas, half-filled d-shell, and 18-electron configuration, respectively, were chosen as B ions that would demonstrate the influence of partial covalent character of B–O linkages on the distortion. Complete reactions to perovskite type oxides were obtained in all cases except $Gd_2O_3 + Ga_2O_3$, and $Dy_2O_3 + Ga_2O_3$. The data showed that distortion increased with the lanthanide contraction in each of the series $LnAlO_3$, $LnFeO_3$, and $LnGaO_3$. The orthorhombic structures of $DyAlO_3$ and $DyFeO_3$ are described. (B.O.G.)

9448 THERMAL CYCLING CREEP OF α-URANIUM. A. C. Roberts (General Electric Co., Ltd., Wembley, Middx, Eng.). Acta Met., 8: 817-19(Nov. 1960).

The regeneration of intergranular stresses when α-uranium is subjected to thermal cycling is studied. Four 6-mm rods were cut from a cast bar of calcium-reduced uranium, swaged to 1-mm wire, with vacuum-annealing at 600°C after each 50% reduction. The wires were coiled into springs and thermally cycled (100 to 300 and 50 to 300°C) with periodic cooling to room temperature to measure the length. The results show that initially the uranium could not support even small loads without deforming plastically. After a few cycles, provided the amplitude is not too large, the material can support small loads elastically, partly due to a redistribution of the intergranular stresses and partly due to work hardening which increases the elastic range. (T.R.H.)

9449 STRUCTURAL EFFECT OF SILICON ON ALUMINUM–URANIUM ALLOYS FOR NUCLEAR REACTORS. D. Gualandi and G. Schileo (Istituto Sperimentale Metalli Leggeri, Novara, Italy and FIAT, Turin). Alluminio, 28: 449-55(1960). (In Italian)

The effect of up to 3.5% silicon on the metallographic and mechanical properties of a 17% Al–U alloy was investigated. In the presence of silicon, the primary crystals of UAl_4 are completely substituted by lattices of UAl_3, containing part of the silicon in solid solution. The presence of primary crystals of UAl_3 instead of UAl_4 improves the engineering properties of the alloy. (auth)

9450 THE RELATION OF STRUCTURE TO ANISOTROPY IN THE THERMAL EXPANSION FOR URANIUM. NEPTUNIUM, AND PLUTONIUM. N. T. Chebotarev. Atomnaya Energ. 10: 43-9(Jan. 1961). (In Russian)

The relation of structure changes to thermal expansion in uranium, neptunium, and plutonium was analyzed. In all examined structures, thermal expansion anisotropy results from the weakening of four covalent bonds and irregular distributions in interatomic distances in crystalline lattices. The established regularities describe certain specific properties of uranium, neptunium, and plutonium. (tr-auth)

9451 STRUCTURE AND THERMAL EXPANSION OF δ AND η PLUTONIUM. S. T. Konobeevskiĭ and N. T. Chebotarev. Atomnaya Energ. 10: 50-7(Jan. 1961). (In Russian)

A new aspect of δ and η plutonium structure is suggested on the basis of increased covalent bonding at reduced temperature. The structure of these modifications is the result of a comparatively small deflection from an ideal grain-centered lattice induced by tetra-covalent bonds. Such a concept explains certain anomalous properties of δ and η plutonium, especially the negative values of the thermal coefficient and volume coefficients and the increase of atomic volume. (tr-auth)

9452 STUDY OF THE SELF-DIFFUSION OF ZIRCONIUM IN THE BODY-CENTERED β PHASE. Dimitri Volokoff, Serge May, and Yves Adda (C.E.A., Saclay). Compt. rend., 251: 2341-3(Nov. 21, 1960). (In French)

The self diffusion of zirconium was studied using the Zr^{95} isotope. The coefficients of self diffusion D were determined in the temperature range from 900 to 1240°. They can be represented by the equation $D(cm^2sec^{-1}) = 4.2 \times 10^{-5}\exp(-24{,}000/RT)$, where R is the perfect gas constant and T is the absolute temperature. (tr-auth)

9453 EFFECT OF ALUMINUM NITRIDE ON THE FORGEABILITY OF STEELS. Paul Bastien and Philippe Portevin. Compt. rend., 251: 2347-9(Nov. 21, 1960). (In French)

The decrease of the forgeability of steels under the effect of aluminum additions, distributed between 0.0045 and 0.090%, was studied in steels with 0.35% carbon. The characteristics of the phenomenon are isolated, and the role played by aluminum nitride is shown. (tr-auth)

9454 X RAY AND ELECTRON MICROSCOPE STUDY OF THE PRECIPITATION IN AN Al–Zn ALLOY WITH 40% ZINC. René Graf and Bernard Genty (O.N.E.R.A., Châtillon-sous-Bagneux, France). Compt. rend., 251: 2517-19 (Nov. 28, 1960). (In French)

The precipitation in Al–Zn alloy with 40% zinc was studied by x-ray diffraction and electron microscopy. The alloy was tempered in water after a 2-hr soaping treatment at 400°C. The alloy was aged at room temperature. The central scattering diagrams show a much larger ring than is found in alloys with 10% zinc. The DS diagrams show that flat rays are the most intense of those which correspond to the (200) ray. After 24 hr weak zinc rays appear which become very intense after 600 hr. At tempering temperatures above 100°C, the DS diagrams show rays of the solid α solution bordered with satellite rays. For long tempering, a second solid solution appears. (J.S.R.)

9455 THE PHASE DIAGRAM OF THE SULFIDE SYSTEM OF YTTRIUM AND CALCIUM. Jean Flahaut, Loris Domange, and Madeleine Patrie. Compt. rend., 251: 2535-7 (Nov. 28, 1960). (In French)

The phase diagram was studied crystallographically on tempered products between 600 and 1370°C. Two CaY_2S_4 phases separated by an inversion point at 1100°C were detected. There was a region of homogeneity of the cubic type Th_3P_4 stable above 980°C. A second region of homogeneity was formed by CaS. (tr-auth)

9456 EQUILIBRIUM IN THE SYSTEM $V_2C-H_2-CH_4-V$. V. I. Alekseev and L. A. Shvartsman. Doklady Akad. Nauk, S.S.S.R., 133: 1331-3(Aug. 21, 1960). (In Russian)

The following reaction was studied: $V_2C(solid) + 2H_2(gas) \rightleftharpoons CH_4(gas) + V(solid)$. The equilibrium constant for this reaction $K_e = P_{CH_4}/(P_{H_2})^2$ was determined experimentally, and it was found that $\log K_e = 2201.9/T - 5.825$ and that the free energy $\Delta G^0_{973-1273°K} = -10{,}050 + 26.65T$. On introducing the equation for the free energy of formation of methane it is found that the free energy $\Delta G^0_{973-1273°K} = -11{,}500 - 0.49T$ for the reaction $2V(solid) + C(solid) = V_2C(solid)$. Thus ΔH, the heat of formation of V_2C is

−11,500 ± 500 cal/gram-mole. The entropy change ΔS = 0.49 cal/gram-mole-degree. The free energy of formation of V_2C can be used to calculate the limiting concentrations of carbon in solid solutions of metals dealing with V_2C in a manner similar to calculating the solubility of carbon in α-iron. Other equilibria involving the carbide V_2C can also be calculated. (TTT)

9457 THE STRUCTURE OF PARTICLES OF GRAPHITIZED, THERMAL CARBON BLACK AND ITS DECOMPOSITION PRODUCTS. E. A. Leont'ev and V. M. Luk'yanovich. Doklady Akad. Nauk, S.S.S.R., 134: 384-6(Sept. 11, 1960). (In Russian)

It was found that particles of carbon black have a structure similar to graphite interspersed with intrusions of amorphous carbon at distances on the order of 100 Å. It is known that oxidizing agents react with carbon atoms in a liquid medium and that on drying and heating there is a disruptive evolution of CO and CO_2 at 180 to 200°C. Hence, a sample of graphitized carbon black fired at 3200° in an inert atmosphere for 20 min was treated with a mixture of 30 ml H_2SO_4 (d = 1.84) and 10 ml HNO_3 (d = 1.40) with the subsequent addition of 10 g of finely powdered $KClO_4$. After washing with water it was observed that the oxidized particles were swollen. On heating the particles burst open, and the shape of the "exploded" particles, as revealed by observations on an electron microscope, could be explained by the assumption that intrusions of amorphous carbon occur in the graphitized carbon black particle. This method is particularly useful in investigating semicrystalline graphitized materials that form such large molecules that analysis by x-ray methods is difficult. (TTT)

9458 GRAPHITE FOR REACTORS. Rodrigo Méndez Peñalosa, Jaime Luis Ortiz de la Torre, and José Luis Otero de la Gándara. Energia nuclear (Madrid) IV: No. 15, 44-61 (July-Sept. 1960). (In Spanish)

A review is given of the fabrication and the physical and chemical properties of nuclear graphite. 45 references. (J.S.R.)

9459 RECRYSTALLIZATION AND "PRESSING EFFECT" OF ZIRCONIUM-CONTAINING ALUMINUM WROUGHT ALLOYS. Bruno Beyer and Hellmuth Seliger. Freiberger Forschungsh., B, 48: 130-41(Jan. 1960). (In German)

A study was made of the recrystallization behavior of zirconium-containing wrought aluminum alloys after extrusion and cold forming. The experiments used pure aluminum and Al−Cu−Mg. It was found that zirconium addition increases the critical total reduction after extrusion so that in practice it is possible to retain the press-effect in half-finished products with greater certainty and to largely suppress the undesirable coarse-grain regions. The recrystallization nucleus growth after critical deformation is greatly decreased, which is important in the forging of light metal pieces. (T.R.H.)

9460 THE EFFECT OF THE DEGREE OF RAREFACTION ON THE HEAT CONDUCTIVITY OF REFRACTORY CERAMICS. V. V. Pustovalov. Inzhener.-Fiz. Zhur., Akad. Nauk Belorus. S.S.R., 3: 57-9(Oct. 1960). (In Russian)

Results are given of the determination of thermal conductivity of refractory ceramics at atmospheric pressure and various degrees of refraction. It is shown that the thermal conductivity of refractory ceramics decreases as a result of reduced thermal transmission of air in ceramics, when the length of free path reaches the order of the diameter of the pores. This is reasonable from the point of view of the molecular kinetic theory of gases. (auth)

9461 HEAT OF SUBLIMATION AND VAPOR PRESSURE OF CARBON. Arthur L. Davis. J. Anomalies, 1: 1-20(Nov. 1960).

Extensive literature citations are made to demonstrate an anomaly in data on the heat of sublimation and vapor pressure of carbon. A model is suggested wherein the heat of sublimation of carbon is directly proportional to temperature over any rectilinear portion of the heat capacity curve for carbon wherein data are available to make an initial heat of sublimation calculation. (T.R.H.)

9462 ELECTRON OPTICAL STUDY OF BASAL DISLOCATIONS IN GRAPHITE. S. Amelinckx and P. Delavignette (Centre d'Etude de l'Energie Nucléaire, Mol, Belgium). J. Appl. Phys., 31: 2126-35(Dec. 1960).

Dislocations having a Burgers vector in the basal plane and lying in this plane were studied in graphite by the use of thin foil transmission electron microscopy. The dislocations are dissociated into ribbons consisting of two partials separated by a stacking fault. Specific models for these dislocations are presented. Hexagonal networks contain extended and contracted nodes. The presence of two types of stacking faults gives rise to singularities which are analyzed in terms of experimentally determined Burgers vectors. The dislocations and even the networks are very mobile along the basal plane. The stacking fault energy is determined as 3 to 5×10^{-2} ergs/cm^2. (auth)

9463 HIGH-TEMPERATURE DISCHARGES IN FERROELECTRIC CERAMICS. John W. Northrip (Sandia Corp., Albuquerque, N. Mex.). J. Appl. Phys., 31: 2293-6(Dec. 1960).

Ceramic disks of barium titanate and lead zirconate titanate, when heated above 100°C, exhibit current discharges which cannot be attributed to the ferroelectric polarization of the material. These discharges are largest in the temperature interval 300 to 600°C and depend primarily on the electrode material and its method of application. Discharges of several millicoulombs at voltages up to one-half volt were obtained from a ceramic disk ½ in. in diameter and 30 mils thick having a silver electrode and an indium counterelectrode. Although thermoelectric, pyroelectric, and electret effects are observed in these samples, these phenomena contribute only a very small portion of the total discharge. At constant temperature near 350°C the discharge decays with time as the sum of two exponentials, falling to half maximum in periods of the order of ½ hr. At higher temperatures the decay rate increases, while temperature cycling produces a voltage cycling superimposed on the decay. These findings support an explanation of the effect in terms of solid state chemical activity between the metallic electrodes and the titanate lattice. (auth)

9464 PREPARATION AND CRYSTAL STRUCTURES OF RuC AND OsC. Charles P. Kempter and M. R. Nadler (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 33: 1580-1(Nov. 1960).

Equimolar metal-graphite mixtures were pressed into 1/16-in.-diameter pellets and fired in a helium atmosphere inside a spectro-grade graphite rod at 2200, 2500, and 3000°C for 15, 60, and 3 min, respectively, for ruthenium-carbon, and 2800 and 3000°C for 15 and 3 min for the osmium-carbon pellets. X-ray-powder-diffraction studies of the reacted mixture revealed metal, graphite, and a hexagonal phase isomorphous with WC. Since unreacted metal was found to be the major phase in all five specimens, additional specimens were made up using 1:3 and 1:10 metal:graphite molar ratios. The best yields of the hexagonal WC type phases were obtained using the latter ratio and heating for 4 hr at 2600°C. X-ray-powder-diffraction

data are tabulated for RuC and OsC at 25°C. Lattice constants and their standard deviations were determined assuming systematic errors in $\Delta a_0/a_0$ directly proportional to $\phi \tan \phi$, where ϕ is the complement of the Bragg angle. (B.O.G.)

9465 PREPARATION AND PROPERTIES OF SCANDIUM DIHYDRIDE. Joseph C. McGuire and Charles P. Kempter (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 33: 1584-5(Nov. 1960).

Scandium dihydride was prepared and studied. Scandium was outgassed at 800°C in a silica tube. The tube was cooled to room temperature and connected to a series of calibrated volumes containing purified hydrogen at slightly below atmospheric pressure. Pressures were indicated on a manometer read by a cathetometer to the nearest 0.05 mm Hg. The metal was heated slowly until reaction was indicated by a drop in the manometer reading. At 450°C reaction was observed, and the experiment was held at 450°C for 16 hr. The metal was cooled slowly to room temperature to promote any additional metal-hydrogen reaction; none was observed. At this point, sufficient hydrogen had reacted to correspond to $ScH_{2.027}$. The possibility was considered that a ScH_3, similar to YH_3, might be formed at lower temperatures. Two repetitions of the process yielded very little additional reaction. It is possible that ScH_3 is formed at higher hydrogen pressures. Vapor pressure data and x-ray powder-diffraction data are tabulated. The lattice constant and its standard deviation were determined by the method of Vogel and Kempter, $a_0 = 4.78309 \pm 0.00047$ A at 25°C. Correcting for refraction this becomes $a_0 = 4.78315$ A. For 4(ScH_2) per unit cell, the theoretical density is 2.851 g/cc, and the Sc−8H bond distance is 2.0712 A. ScH_2 may be useful as a high-temperature neutron moderator because it contains 7.31×10^{22} hydrogen atoms/cc. (B.O.G.)

9466 LATTICE HEAT CAPACITY OF THE RARE EARTHS. HEAT CAPACITIES OF YTTRIUM AND LUTETIUM FROM 15−350°K. L. D. Jennings, R. E. Miller, and F. H. Spedding (Inst. for Atomic Research and Dept. of Chem., Iowa State Univ., Ames). J. Chem. Phys., 33: 1849-52 (Dec. 1960).

The heat capacities of lutetium and yttrium were measured and found to have the same dependence on a reduced temperature as does that of lanthanum. The lattice heat capacities are given by Θ values of 130.7, 166.0, and 213.7 for lanthanum, lutetium, and yttrium and the corresponding electronic heat capacities are given by γ values of 100, 95, and 85×10^{-4} joule/g atom-deg^2. (auth)

9467 LATTICE DIMENSIONS OF NbC AS A FUNCTION OF STOICHIOMETRY. C. P. Kempter, E. K. Storms, and R. J. Fries (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 33: 1873-4 (Dec. 1960).

The variation of the lattice constant of NbC with the composition was determined at 25°C, and the data combined with earlier data to cover the C/Nb molar ratio range 0.700 to 0.996. A least-squares quadratic equation fitting the curve on a lattice constant vs. C/Nb graph is $a_0 = 4.09847 + 0.71820(C/Nb) - 0.34570(C/Nb)^2$. A plot of the theoretical densities vs. C/Nb is included; the phase reaches a minimum density of 7.716 g/cm^3 at C/Nb = 0.785 and a maximum density of 7.796 g/cm^3 at C/Nb = 1.000, with a density of 7.730 at C/Nb = 0.700. It is concluded that the phase density cannot necessarily be used to define the lattice constant or C/Nb molar ratio. (D.L.C.)

9468 VAPOR PRESSURE OF SILICON AND THE DISSOCIATION PRESSURE OF SILICON CARBIDE. Stanley G. Davis, Donald F. Anthrop, and Alan W. Searcy (Univ. of California, Berkeley). J. Chem. Phys., 34: 659-64(Feb. 1961).

The vapor pressure of silicon and the dissociation pressure of silicon carbide were obtained from total weight loss experiments with Knudsen effusion cells. Combination of the measured data with known entropies yields at 298°K for the heat of sublimation of silicon to silicon atoms 108.4 ± 3 kcal and for the heat of the reaction $SiC_{(s)} = Si_{(g)} + C_{(s)}$ 126.0 ± 3 kcal. From the pressure studies and from phase equilibria for the condensed phase silicon-carbon system, the heats of formation for both the cubic and hexagonal modifications of silicon carbide are concluded to be −15.0 ± 2 kcal. (auth)

9469 THERMODYNAMIC PROPERTIES OF MOLTEN MIXTURES OF CERIUM CHLORIDE AND CALCIUM CHLORIDE. S. Senderoff, G. W. Mellors, and R. I. Bretz (Union Carbide Corp., Parma, Ohio). J. Electrochem. Soc., 108: 93-6 (Jan. 1961).

The thermodynamic properties of solutions of $CeCl_3$ in $CaCl_2$ were determined by emf measurements over the concentration range unity to 10^{-3} mole fraction and the temperature range 800 to 925°C. The solutions behaved nearly ideally under all conditions with small deviations, if any, in the positive direction. The solvent effect on the activity of the solute cation was found to depend on the "charge density" of the solvent cation in a manner consistent with previous work. (auth)

9470 THE DIFFUSION COEFFICIENT FOR OXYGEN IN ALPHA-ZIRCONIUM. M. Davis, K. R. Montgomery, and J. Standring (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.). J. Inst. Metals, 89: 172-4(Jan. 1961).

The coefficient was determined by microhardness measurements within the range 400 to 850°C. The results are expressible as $D = 69.2 \exp(-56{,}187/RT)$ above 700°C and as $D = 9.13 \times 10^{-5} \exp(-29{,}815/RT)$ below 700°C. (auth)

9471 ELECTRON MICROGRAPH AND MICRODIFFRACTION STRUCTURAL STUDY OF THIN SECTIONS OF BERYLLIUM. A. Saulnier (Service des Recherches de la Cie. Péchiney, Chambéry, France). J. Nuclear Materials, 2: 299-309 (Dec. 1960). (In French)

A simple and direct technique was developed for making thin sections of beryllium which can be directly observed in an electron microscope. This was used for comparing the structure, both in the cold-worked and the annealed conditions, of thin beryllium sheets made by drawing and rolling either cast billets or billets produced by powder metallurgy. Significant differences were observed in the distribution of dislocations in the two cases. The behavior of the metal during annealing at temperature in the range 800 to 1000°C was found to depend on the mode of preparation of the metal and on the degree of deformation. The sheets either recrystallized in a straightforward manner or else dislocations were eliminated gradually with simultaneous slow movement of grain boundaries already present in the deformed structure. The distribution of oxide in the sintered metal can readily be recognized by electron micrography or microdiffraction of thin sections. Alternatively, the distribution can be determined by an extraction method with the aid of carbon replicas. (auth)

9472 ON THE LOCATION AND MOTION OF RARE GAS ATOMS IN METALS. C. W. Tucker, Jr. and F. J. Norton (General Electric Research Lab., Schenectady, N. Y.). J. Nuclear Materials, 2: 329-34 (Dec. 1960). (In English)

Using potentials of about 40 kv, rare-gas ions were ac-

celerated into metal films and foils. In spite of the fact that as much as 2 at.% argon was loaded into the metal lattice, little or no x-ray effect due to lattice distortion was observed. This result suggests that rare-gas atoms coming to rest in a metal lattice capture vacancies. When rare-gas-loaded metal foils are heated in a vacuum system connected to a mass spectrometer, the evolution of the gas can be measured. The evolution of argon from foils of Ag, Au, Al, and Pb and Kr from uranium was studied with interesting variations from metal to metal. Exploratory experiments with other rare gases indicate similar results. The combination of the ion bombardment and mass spectrometer techniques appears very promising for the study of the behavior of rare gases in crystals. (auth)

9473 KRYPTON EVOLUTION FROM METALLIC URANIUM. Francis J. Norton and C. W. Tucker, Jr. (General Electric Research Lab., Schenectady, N. Y.). J. Nuclear Materials, 2: 350-2 (Dec. 1960). (In English)

Krypton ions were put into uranium foil at 40 kv. The rate and temperature of release of the krypton gas was studied by the mass spectrometer. Evolution began below 250°C and showed several peak rates. The temperature for release in this case was much lower than that found in other work on fission gases formed in situ. (auth)

9474 THE PLASTIC DEFORMATION OF MONOCLINIC ALPHA PLUTONIUM. S. E. Bronisz and A. E. Gorum (Los Alamos Scientific Lab., N. Mex.). J. Nuclear Materials, 2: 453-5(Dec. 1960). (In English)

An investigation was carried out to determine the effect of temperature and strain rate on the plastic deformation of α plutonium and to determine the mode or modes of deformation which contribute to the plastic flow. All experiments were performed with fine-grained polycrystalline specimens. The stress-strain compression tests were run in an oil bath at temperatures from 24 to 100°C. It was found that the yield stress of α plutonium varies directly with strain rate and inversely with temperature. After the application of a strain of 1%, an orange peel structure began to form. Further straining caused this structure to become more pronounced. Slip lines and grain boundary sliding occurred at approximately 2% strain. Metallographically prepared sections of the stress-strain specimens revealed the presence of twin-like bands. (M.C.G.)

9475 THERMODYNAMIC PROPERTIES OF TiC AT HIGH TEMPERATURES. S. Fujishiro and N. A. Gokcen (Univ. of Pennsylvania, Philadelphia). J. Phys. Chem., 65: 161-3(Jan. 1961).

Equilibrium pressure of gaseous titanium in the reaction TiC(s) = C(graphite) + Ti(g) was determined in the range of 2383 to 2593°K by means of graphite Knudsen cells. Results are expressed by log P_{Ti} (atm.) = $-(30.830/T) + 7.65$ and the related thermodynamic properties of TiC are calculated. (auth)

9476 QUADRUPOLE EFFECTS IN THE NUCLEAR MAGNETIC RESONANCE OF DILUTED ALLOYS. A. Blandin and J. Friedel (Faculté des Sciences, Orsay, France). J. phys. radium, 21: 689-95(Oct. 1960). (In French)

The strong intensity changes in the nuclear magnetic resonance of dilute alloys are the consequence of the electronic density oscillations $\Delta\rho$ that are created at large distances by the dissolved impurities. For a nucleus at a distance r from an impurity, $\Delta\rho$ is proportional to the function $\cos(2k_F r + \varphi)/r^3$ and gives field gradients of the same asymptotic form, multiplied by a constant depending strongly on the s, p, or d character of the Bloch wave functions at the Fermi level of the pure metal. The experimental results for copper- or aluminum-base alloys are discussed. Analogous conclusions have been simultaneously obtained by Kohn and Vosko. (auth)

9477 USE OF LOW-CARBON UNALLOYED STEELS INSTEAD OF CERTAIN HIGH-STRENGTH ALLOY STEELS. M. E. Blanter, K. P. Koryagin, and O. V. Martishin (All-Union Mechanical Engineering Correspondence Institute). Metalloved. i Termicheskaya Obrabotka Metal., No. 12, 2-7 (1960). (In Russian)

The low-carbon steels have only a limited use because they cannot be easily tempered. In order to attempt the replacement of special high-alloy steels, the behavior of low-carbon unalloyed steels subjected to various heat treatments was studied. Using steels with carbon contents ranging from 0.13 to 0.16% it was found that the martensitic phase was not decomposed during quenching because of supersaturation of the solid solution which retains the carbon. Quenching the steels at 550 to 600°C at a rate of 2400 to 2600 °C/sec with a 8 to 10% NaOH solution improved their strength considerably, making them comparable to high-alloy steels at high temperatures. After quenching and annealing, the critical embrittlement temperature remained below −70°C. The presence of ferrite in the center of the steel did not interfere with the cold brittleness. Tests showed that such highly tempered low-carbon steels can successfully replace high-alloy steels in many applications, and they have the added advantage of being more easily weldable. (TTT)

9478 SOME NEW INTERMETALLIC COMPOUNDS OF THORIUM OF THE TYPE Th_7X_3. J. R. Thomson (Imperial Coll. of Science and Tech., London). Nature, 189: 217 (Jan. 21, 1961).

Metallographic and x-ray studies were made on as-cast and annealed samples of thorium alloys containing Ru, Rh, Pd, Os, Ir, and Pt up to 33 at.% of each. The intermetallic compounds richest in thorium were found to be of the type Th_7X_3 in every case, except the alloy containing palladium, for which the compound was Th_2Pd, and the eutectic compositions and temperatures of all those compounds with thorium are tabulated. X-ray-powder patterns of the Th_7X_3 compounds are in agreement with those of Th_7Fe_3, and their lattice parameters, axial ratios, and x-ray densities are tabulated. (D.L.C.)

9479 SOME STRUCTURAL RESULTS ON METALLIC PHASES. VI. K. Schubert, T. R. Anantharaman, H. O. K. Ata, et al. (Max Planck Inst. für Metallforschung, Stuttgart, Germany). Naturwissenschaften, 47: 512(Nov. 1960). (In German)

Results on the crystal structures in the metallic systems Zr−Al, Cr−Ga, Mn−Ga, Fe−Ga, Hf−Al, Zr−Ga, Hf−Au, Nb−Au, and Zr−Sn are tabulated. (J.S.R.)

9480 ULTRASONIC INSPECTION OF SUBMARINE STEEL WELDMENTS. N. A. Sinclair and M. M. Nanda (Electric Boat Co., Groton, Conn.). Nondestructive Testing, 19: 58-64(Jan.-Feb. 1961).

A laboratory investigation was undertaken to develop ultrasonic inspection techniques and, concurrently, to establish tentative acceptance standards for butt weldments in ship plate which would be approximately equivalent to the standards established for radiographic inspection. Butt weldments containing defects of porosity, cracks, inclusions, lack of penetration, and flawless control weldments were prepared in 1-in.-thick HY-80 (80,000-psi yield strength) steel. These weldments were inspected by both ultrasonic and radiographic methods. The ultrasonic inspection was performed by scanning the weld metal and adjacent heat-

affected zone with a $\frac{3}{8}$-in.-diameter 2.25-mc 45° angle-beam search unit. Instrument-sensitivity and flaw-acceptance levels were established with reference to a $\frac{1}{16}$-in.-diameter $\frac{1}{2}$-in.-deep hole in a 1-in.-thick HY-80 steel plate. The ultrasonic acceptance-rejection standard was established at a level of instrument sensitivity which would reject those cracks rejected by radiography. Since inclusions and porosity have lower reflective power than cracks, an ultrasonic standard sensitive enough to reject cracks of the size rejected by radiography would not reject inclusions and porosity of a size considered rejectable by radiography standards. Separate standards could not be established for each type of defect, however, since it was impossible to determine reliably the type of flaw from the pattern of the ultrasonic signal with confidence. (auth)

9481 SOME PHASE RELATIONS OF THE $BaO-UO_2-O_2$ SYSTEM. Włodzimierz Trzebiatowski and Andrzej Jabłoński (Technical Univ., Wrocław, Poland). Nukleonika, 5: 587-96(1960). (In English)

To establish the phase relations of the $BaO-UO_2$ system, mixtures of $BaCO_3$ and UO_2 in different proportions were heated at 1200°C in hydrogen and then examined by x-ray powder methods. Up to 50 mole % BaO there exists a heterogeneous phase region composed of UO_2 of the fluorite structure and of $BaUO_3$ representing the pseudocubic perovskite structure without alteration of their lattice constants, which indicates the lack of solid solutions. Between 50 and 75 mole % BaO, the samples are homogenous and the elementary cell of $BaUO_3$ changes from pseudocubic to cubic, finally exposing new superstructure lines. This points to a continuous transition from the simple perovskite cell to the face-centered of the $(NH_4)_3FeF_6$ type. Samples containing more than 75 mole % BaO decompose during the heating offering free BaO content. $BaUO_3$ oxidizes itself at room temperature with gradual decreasing lattice constant from 4.402 kX at $BaUO_{3.0}$ to 4.383 kX at $BaUO_{3.35}$. From the density measurements of the oxidized samples, the formation of an interstitial solution of the oxygen in the $BaUO_3$ lattice is expected. At higher oxygen content $BaUO_4$ appears. (auth)

9482 TUNNELLING FROM A MANY-PARTICLE POINT OF VIEW. J. Bardeen (Univ. of Illinois, Urbana). Phys. Rev. Letters, 6: 57-9(Jan. 15, 1961).

The tunneling current flowing between two metals separated by a thin oxide layer is discussed from a many-particle point of view. It is shown that the matrix element may be treated as a constant in the interpretation of experiments. Two many-particle systems which may be defined in terms of quasi-particle occupation numbers of the two metals were considered. The quasi-particles did not correspond to plane waves but to waves which are reflected at the barrier and which drop exponentially with distance into the barrier region. (M.C.G.)

9483 INTERMETALLIC DIFFUSION IN GOLD-LEAD SYSTEMS. A. Ascoli and E. Germagnoli (Centro Informazioni Studi Esperienze, Milan). Pure and Appl. Chem., 1: No. 1, 139-41(1960). (In English)

Some preliminary results on the diffusion of gold in lead, obtained using radioactive tracers, are presented. (tr-auth)

9484 BEHAVIOR OF MAGNESIUM AND TWO OF ITS ALLOYS HEATED IN CARBON DIOXIDE. M. L. Boussion, R. Darras, and D. Leclerq. Rev. mét., 56: 61-7(1959). (In French)

Magnesium specimens either pure or lightly alloyed with zirconium and zinc were exposed to carbon dioxide under a pressure of 15 kg/cm^2 for 3000 hr at from 400 to 500°C. The weight-increase curves showed that oxidation remained slight; with increased temperature the plateau was raised and was reached more rapidly. Nevertheless, a deposit of carbon appeared at 450°C, and upwards, and the presence of zinc caused marked sublimation above 550°C. Further, it was also shown that distinct proportions of oxygen, nitrogen, or air in the carbon dioxide did not appreciably increase oxidation, even at 500°C. (auth)

9485 THE MANY-ELECTRON THEORY OF IONIC CRYSTALS. S. V. Vonsovskii and M. Sh. Giterman (Gorkii State Univ., U.S.S.R.). Soviet Phys.-Solid State, 2: 1622-32 (Feb. 1961).

A many-electron treatment of ionic crystals is carried out from the phenomenological and model points of view by means of the method of elementary excitations. The energy spectra of the boson and fermion branches of the elementary excitations are obtained by taking into account the interactions between electrons and the electron-phonon interaction. The general theory is applied in particular to the study of "polaron" excitations, the anomaly of the kinetic coefficients near the Curie point in ferromagnetic and antiferromagnetic semiconductors, and the Stark effect for exciton levels. (auth)

9486 THE TERNARY PHASE IN THE COPPER-ALUMINUM-ZINC SYSTEM. II. THE PHASE REGION OF THE T PHASE OVER 500°. Heinz Herbert Arndt and Karl Moeller. Z. Metallk., 51: 656-62(Nov. 1960). (In German)

By a high temperature x ray technique it was found that in the system copper-aluminum-zinc the T phase does not form a solid solution with any other crystal. The newly introduced ζ phase forms with the δ phase above 680°C a homogeneous solid solution field. Based on the results a new transformation scheme in the system copper-aluminum-zinc is proposed. (auth)

9487 MAGNETIC PROPERTIES OF LANTHANUM AND PRASEODYMIUM ORTHOFERRITE ON PARTIAL REPLACEMENT OF Fe^{3+} BY Al^{3+}. K. P. Belov, M. A. Zaĭtseva, and A. M. Kadomtseva (Moscow State Univ., U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1148-50(Oct. 1960). (In Russian)

A partial replacement of Fe^{3+} (ionic radius 0.67 A) by nonmagnetic Al^{3+} (ionic radius 0.57 A) was studied in $La_2O_3 \cdot Fe_2O_3$ and $Pr_2O_3 \cdot Fe_2O_3$. The hysteresis loop for $La_2O_3 \cdot 0.9\ Fe_2O_3 \cdot 0.1\ Al_2O_3$, taken at the Curie point in a magnetic field of 4000 gauss, was more symmetric than that of $La_2O_3 \cdot Fe_2O_3$. The thermal magnetic after-effect is zero at 3000 gauss, indicating a loss of coercive force. Reduced coercive force was also observed in $Pr_2O_3 \cdot 0.9\ Fe_2O_3 \cdot 0.1\ Al_2O_3$. The variations of magnetization with temperature are plotted. It is shown that partial replacement of Fe^{3+} by Al^{3+} with zero magnetic moment resulted in an increase of the magnetization which is obviously related to the difference between the Fe^{3+} and Al^{3+} sublattices. (R.V.J.)

9488 THERMAL CONDUCTIVITY OF HIGH PURITY THALLIUM AND TIN. N. V. Zavaritskiĭ (Inst. of Problems in Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1571-7(Dec. 1960). (In Russian)

The thermal conductivity of thallium and tin single crystals of various purity in the normal (K_n) and superconducting (K_s) states was studied. Scattering of electrons in the normal state was found to deviate from additivity. Variation of K_s/K_n when electron scattering on lattice imperfections changed to scattering on thermal oscillations was studied. The results are compared with the theoretical predictions. (auth)

9489 EQUILIBRIUM STUDIES OF THE SYSTEM Zr–N AT HIGH TEMPERATURES. E. I. Smagina, V. S. Kutsev, and B. F. Ormont (Technological Inst. of Heavy Industry, Moscow, U.S.S.R.). Zhur. Fiz. Khim., 34: 2329-35(Oct. 1960). (In Russian)

A manometric method was developed for investigating equilibria in high-melting nitride systems. The method is suitable for temperatures up to 2800°K and pressures ranging from 10^{-1} to 300 mm Hg. Equilibrium in the system Zr–N was studied over the above ranges of temperature and pressure for compositions from $Zr_1N_{0.7}$ to $Zr_1N_{0.96}$. It was found that for pressures ranging from 10^{-1} to 300 mm Hg on equilibrium, the phases ZrN_x–N_2 exist rather than ZrN, Zr_3, and N_2. Equilibrium compositions of ZrN_x, depending upon T and P, are given. (auth)

9490 REACTION OF HAFNIUM DIOXIDE AND TITANIUM DIOXIDE. N. A. Godina, E. K. Keller, and V. S. Rudenko (Inst. of Chemistry of Silicates, Academy of Sciences, USSR). Zhur. Neorg. Khim., 5: 2795-7(Dec. 1960). (In Russian)

Reactions between hafnium dioxide (99% HfO_2) and titanium dioxide (rutile with 99.7% TiO_2) were studied at 1350 to 1650°C. The reactions produced a titanium hafnium compound ($HfTiO_2$) which crystallized into a rhombic structure. Solid solutions with limited solubility were formed in the HfO_2–TiO_2 system, in addition to the constant composition. (R.V.J.)

9491 CONSTITUTION DIAGRAM OF V_2O_5–KPO_3. V. V. Illarinov, R. P. Ozerov, and E. V. Kil'disheva. Zhur. Neorg. Khim., 5: 2802-3(Dec. 1960). (In Russian)

The constitution diagram of V_2O_5–K_2O–P_2O_5, studied along the line of KPO_3–V_2O_5, showed the presence of $KPO_3 \cdot V_2O$ and $4KPO_3 \cdot V_2O$ formed between two solid phases at 300 to 380°C. Both compounds melt congruently at 534 and 846°C. (R.V.J.)

9492 ALUMINA PROPERTIES. Technical Paper No. 10. Second Revision. J. W. Newsome, H. W. Heiser, A. S. Russell, and H. C. Stumpf (Aluminum Co. of America, Pittsburgh). 1960. 88p.

Literature values for the properties of the aluminas are compiled critically in this publication. The historical development of the names for the many varieties is traced, and the systems of nomenclature are compared. Three major classifications are distinguished: the high temperature forms that are produced in general by calcination over 1200°C, the transition forms, and the hydrates. For each phase the following information is assembled if it is available: occurrence in nature; preparation; crystal structure; optical, thermal, electrical, magnetic, mechanical, and surface properties. The interesting phase transformations are given particular attention. Alcoa activated alumina is discussed separately with emphasis on its structure and its applications in drying, chromatography, catalysis, and oil maintenance. Commercial forms and uses of Alcoa calcined, tabular, and hydrated aluminas are also described. In many cases the data are summarized in figures and tables. An extensive bibliography and subject index are included. (auth)

9493 BERYLLIUM. Jack Schubert. p.170-5 of "McGraw-Hill Encyclopedia of Science and Technology." [New York], McGraw-Hill Book Co., Inc., 1960.

Physical and chemical properties, compounds, nuclear properties, occurrence, and uses of beryllium are discussed. Analytical techniques for determination and extraction and mining procedures are described. The development of the commercial production of beryllium is reviewed. (M.C.G.)

9494 BIBLIOGRAPHY ON METALLURGY OF HIGH-PURITY TUNGSTEN, JANUARY 1911 THROUGH FEBRUARY 1959. Earl T. Hayes and Ruth A. Pritchard (Bureau of Mines). Information Circular 7953. 1960. 46p. $0.35 (GPO).

A selected bibliography of 262 references is given on the metallurgy of high-purity tungsten. Only those references that concern improvements in purity are included. Most of the items refer to publications issued within the past five years. (B.O.G.)

9495 QUENCHED-IN LATTICE DEFECTS IN GRAPHITE. G. R. Hennig and M. A. Kanter (Argonne National Lab., Ill.). p.141-4 of "Proceedings of the Fourth Conference on Carbon." New York, Pergamon Press, 1960.

Lattice defects introduced in graphite crystals by irradiation can be identified even in low concentrations by the surface markings produced by catalytic oxidation. These defects facilitate the penetration of iron catalysts along the c-axis of the crystals heated in oxygen at 700°C, thus producing readily identifiable pits. The catalyst does not produce such pits in the absence of lattice defects. The lattice defect responsible for this effect is believed to be the vacancy. Heat treatment of graphite crystals was found to have a marked effect on the mechanism of subsequent catalytic oxidation. Pit formation was observed in crystals which were heated to 2300 to 2500°C or in those which were cooled slowly from higher temperatures. No pit formation was observed in crystals quenched from temperatures above 2700°C or in those found in nature and given no heat treatment. The kinetics of the process imply the presence of two kinds of lattice defects at high temperatures. (auth)

9496 ELECTRON MICROSCOPE STUDIES OF GRAPHITE SINGLE CRYSTALS. G. R. Hennig (Argonne National Lab., Ill.). p.145-54 of "Proceedings of the Fourth Conference on Carbon." New York, Pergamon Press, 1960.

A number of chemical reactions of graphite were followed by kinetic studies on single crystals and by simultaneous microscope and electron microscope studies of the surface structure. The reactions studied include reactions with CO_2, O_2, O_3, O, and a preliminary study of the sublimation process. For any one of these reactions, the effect of crystal perfection, previous heat treatment, previous neutron or γ irradiation, and partial annealing of the ensuing radiation effects were studied. Furthermore, the effects of catalysts and of inhibitors on each reaction were examined. Most of the electron microscope studies were carried out by shadowing and replicating the graphite crystals. A method was also developed of preparing plane parallel or wedge-shaped single crystal fragments sufficiently thin for direct examination in the electron microscope. Some observations related to dislocations and radiation damage in these are discussed. (auth)

9497 RETENTION OF PROTONS BY GRAPHITE. George L. Montet (Argonne National Lab., Ill.). p.159-64 of "Proceedings of the Fourth Conference on Carbon." New York, Pergamon Press, 1960.

An investigation of some of the interactions of the hydrogen-graphite system was carried out. The results of previous investigators were confirmed and extended. It was found that it is possible to cause massive graphite to take up hydrogen if the graphite is made the cathode in a glow discharge. The amount of hydrogen taken up was a function of the temperature as was the rate of evolution of hydrogen from hydrogen-impregnated graphite. The activation energy for the movement of hydrogen through graphite was found to be 13 kcal. The proton bombardment associated with the discharge caused graphite to sputter. No systematic study of the sputtering was under-

taken, but it was observed that the sputtered carbon readily combines with hydrogen to form simple hydrocarbons. Attempts were made to ascertain if the hydrogen driven into the graphite forms a lamellar compound. No permanent change in the electrical properties of graphite was detected and magnetic resonance studies indicate that the hydrogen is not present in its atomic state. However, these results are not conclusive evidence against the formation of a lamellar compound. (auth)

9498 ACCEPTOR AND DONOR IMPURITIES IN GRAPHITE. Gerhart R. Hennig (Argonne National Lab., Ill.). p.221-6 of "Proceedings of the Fourth Conference on Carbon." New York, Pergamon Press, 1960.

The effects of donor and acceptor impurities in graphite are reviewed. Five different types of impurities or defects which affect the electron distribution in graphite are known. These are ordered and disordered interstitial chemical impurities, substitutional impurities, radiation induced disorder, and quenched-in vacancies. Ordered interstitial chemical impurities (lamellar compounds) were introduced and studied in polycrystalline and in single crystal graphite. Disordered interstitial impurities (residue compounds) were studied only in polycrystalline graphite. Substitutional impurities were introduced in both polycrystalline and single crystal graphite, but only one impurity, boron, was studied. Effects of radiation were studied in detail, but were complicated because different centers were present. Vacancies or other lattice defects can apparently be introduced even in single crystals by quenching from high temperatures. (auth)

9499 IMPROVEMENTS IN OR RELATING TO MAGNESIUM BASE ALLOYS. (to Magnesium Elektron Limited). British Patent 848,036. Sept. 14, 1960.

A magnesium alloy having high resistance to creep at temperatures up to 400°C and good room temperature properties, e.g., weldability, working, etc. is offered. It has the following composition: rare earth metals (preferably misch metal or cerium) 0.5 to 1.5%, zinc 0.25 to 1.25%, zirconium 0.2 to 1.0%, and the balance magnesium. Beryllium up to 30 ppm and manganese up to 0.3% may be incorporated for improved oxidation and creep resistance at high temperatures. (D.L.C.)

9500 URANIUM–ALUMINUM ALLOY, CONTAINING SILICON FOR FUEL ELEMENTS. (to U. S. Atomic Energy Commission). French Patent 1,210,887. Oct. 5, 1959.

The manufacture of canned fuel elements with a core of U–Al alloy offers considerable difficulties when the uranium concentration in the alloy exceeds 25% by weight. These difficulties (e.g., "dog-boning") are due to the formation of UAl_4. The formation of UAl_4 can be substantially suppressed by incorporating in the alloy Si, Ti, Ge, Zr, Sn, Pb, In, Tl, Fe, Nb, or Ga, the first five and especially Si being preferred. Starting with an alloy mix consisting of 3.5 to 10 at.% uranium and 0.5 to 20 at.% additive, preferably 5 at.% silicon the balance being aluminum, fuel alloys may be obtained which consist substantially of aluminum and UAl_3, preferred composition containing 9.4 at.% uranium and 65% by weight UAl_3. (NPO)

9501 VITREOUS PRODUCTS AND THEIR APPLICATION IN NUCLEAR REACTORS. (to Société Anonyme des Manufactures des Glaces et Produits Chimiques de Saint-Gobain). French Patent 1,220,086. Jan. 4, 1960.

Glasses are described that are suitable for the manufacture of small fuel spheres for homogeneous suspension reactors. They have the following composition (in wt.%): SiO_2 25 to 35, $TiO_2 + ZrO_2$ 10 to 25 (ZrO_2 5 to 10), MO (M = alkaline earth metal) + ZnO + MgO + BeO 20 to 40 (Mo 8 to 38, ZnO 0 to 15, MgO 2 to 5, BeO 0 to 5), and UO_2 and/or ThO_2 20 to 45, the following composition being particularly preferred: SiO_2 30, TiO_2 7, ZrO_2 7, CaO 12, ZnO 8,5, MgO 3, BeO 2.5, and UO_2 30. The high-corrosion resistance toward H_2O and D_2O can be further improved by coating the spheres with insoluble magnesium or beryllium silicate (e.g., by treating them with a $MgCl_2$ solution) and/or by adding a small quantity of magnesium or beryllium hydroxide or of a slightly hydrolyzable magnesium or beryllium salt to the aqueous carrier. (NPO)

Radiation Effects

9502 (BMI-1484) A STUDY OF THE RADIATION STABILITY OF UO_2 DISPERSIONS IN BeO. David G. Freas, James H. Saling, Herbert D. Sheets, John H. Stang, John E. Gates, and Ronald F. Dickerson (Battelle Memorial Inst , Columbus, Ohio). Dec. 9, 1960. 29p. Contract W-7405-eng-92.

An experiment was performed to determine the radiation stability of beryllium oxide fueled with approximately 56 wt.% UO_2. Pellets of $BeO-UO_2$ were prepared by cold-pressing techniques followed by sintering at 2800°F for 2 hr in a hydrogen atmosphere. These pellets were contained in Hastelloy-X tubes sealed by heliarc welding. Temperature measurements and burn-up analysis by isotopic techniques indicated that the specimen surface temperatures ranged from 1450 to 1725°F with burn-ups ranging from 1.5 to 2.0 at.% of the U^{235}. A specimen similar to the irradiation specimens was thermally cycled at temperatures simulating, as closely as possible, those experienced by the irradiation specimens. These fueled pellets did not show any changes in their physical properties or microstructures. The postirradiation examination of the specimens from Capsule GCRE-BRR-II included fission-gas analyses, dimensional and density measurements, isotopic burn-up analysis, and detailed metallographic examinations of both the fueled BeO pellets and the Hastelloy-X tubes. Only negligible changes in the physical properties were detected. The visual and metallographic examinations of the fueled BeO pellets did not reveal any structural changes. An irregular ring type configuration was observed on the inner surface of the Hastelloy-X tubes. The metallographic examination of a longitudinal edge of these tubes showed ridges and recessed areas which by measurement corresponded relatively well with the configuration observed on the inner surface. These results indicate that BeO fueled with approximately 56 wt.% UO_2 dispersions withstood irradiation to 2 at.% burn-up of the U^{235} at temperatures near 1800°F without any detrimental effects. (auth)

9503 (DP-160) IRRADIATION OF THORIUM SLUGS. Robert P. Marshall (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). May 1956. Decl. June 10, 1960. 19p. Contract AT(07-2)-1.

Ninety-two thorium slugs were irradiated in the Hanford piles to study the dimensional stability of the metal. The burnups that were incurred covered the range from 300 to 2800 ppm of the Th^{232}. Slugs with burnups as high as 800 ppm were examined for visual and dimensional changes. The dimensional stability of these slugs was excellent, and no significant corrosion occurred on the aluminum cans. A cursory examination of slugs with burnups of greater than 800 ppm showed no gross dimensional instability. (auth)

9504 (GEAP-3108(Pt.2)) IRRADIATION AND EXAMINATION OF VIBRATORY PACKED UO_2 HIGH BURNUP

PROGRAM FUEL ELEMENTS. Technical Report. T. J. Slosek and B. Weidenbaum (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Feb. 26, 1960. 57p. Contract AT(04-3)-189.

Four fuel elements, each of which consisted of 36 rods (0.25 in. OD) containing 22% enriched UO_2 powder clad with stainless steel, were irradiated. Two of these elements, G1 and G2, contained UO_2 powder which had been compacted by vibratory packing to apparent bulk densities of from 53 to 65% of theoretical. After elements G1 and G2 had achieved a peak burn-up of approximately 2% of the total uranium atoms, four rods were removed from each element and were destructively examined. Both elements performed satisfactorily during irradiation at surface heat fluxes up to 350,000 Btu/hr/sq ft. The fuel in these elements redistributed radially to form a central void. It is postulated that the central void is formed by a mechanism of sublimation of the UO_2 followed by vapor phase migration and redeposition on cooler surfaces. Axial redistribution of the fuel resulted in the formation of small transverse voids in some of the rods. The transverse voids were much more pronounced in the rods that did not contain TiO_2 than in those with TiO_2 added to the UO_2. Symmetry of the fuel compact about the axis was better maintained in the rods that contained UO_2 with TiO_2 than in those which did not contain TiO_2. Fission-gas release values ranged from 39 to 100% of theoretical based on γ spectrometric Kr^{85} analyses. Release values were significantly lower in fuels that contained TiO_2 than in those that contained UO_2 alone. (auth)

9505 (NP-9720) RELIABILITY TESTING OF CAPACITORS IN COMBINED ENVIRONMENTS. S. G. Pryor, III (Lockheed Nuclear Products, Marietta, Ga.). December 1960. 61p. Contract AF33(600)-38947.

Specimens of 1.0 μf glass-to-metal sealed tubular paper capacitors with extended foil construction, 1.0 μf solid electrolyte metal-cased hermetically sealed tantalum capacitors, and 1.0 μf metal-cased hermetically sealed Mylar capacitors were tested at 85°C to a time integrated dose of 2.18×10^{16} nvt > 2.9 Mev, 9.06×10^{10} ergs/g(C) gamma. The capacitance, dissipation, and leakage current of 100 each of the paper and tantalum capacitors and 98 Mylar capacitors were measured at various time intervals and increasing integrated radiation doses for a total of approximately 5600 measurements. Failure is defined as the first measurement of capacitance which exceeds the manufacturers' tolerance. Failures were counted during each data recording period and mathematical computations completed to determine the probability that a capacitor would perform its function under the given temperature and nuclear radiation conditions. Catastrophic failures, defined as electrical shorts or opens, are also used for comparison. The threshold dose for each type of capacitor was determined. All data presented have a statistical confidence level of 96%. (auth)

9506 (NP-9776) EVALUATION AND DEVELOPMENT OF MIL-C-14157 CAPACITORS FOR NUCLEAR RADIATION ENVIRONMENT. Scientific Report No. 6. E. R. Pfaff (Admiral Corp., Chicago). Feb. 1961. 38p. Contract Nobsr-77612.

Capacitors impregnated with inhibited FC-43 and inhibited bis(phenoxyphenyl) ether dielectric fluids failed during γ irradiation after 63 and 235 hr, respectively. Cross-linked polystyrene capacitors which were irradiated at room temperature failed in 377 hr. The standard CPM08 capacitors survived 1000 hr of irradiation at room temperature. Capacitors subjected to post irradiation environmental tests survived. Six of twelve of the Bendix Scintilla (E-200) capacitors survived the elevated temperature γ irradiation test. The E-200 units are thus the most radiation-resistant capacitors that have been tested thus far. Capacitors are being manufactured with isocyanate treated Mylar, cyanoethylated Kraft paper, and the radiation-resistant dielectric fluids. (auth)

9507 (NP-9779) RESEARCH ON SOLID STATE RADIATION-INDUCED PHENOMENA. Third Quarterly Report for Months Including August, September, and October. Hartmut Kallmann (New York Univ., New York). Dec. 1960. 32p. Contract DA 36-039 SC-85126.

In solutions energy transfer from the bulk to emitter may occur by means of different processes. Methods of discriminating among the processes by adding quenching materials and studying resulting effects on the fluorescence are examined. The experimental results are compared with a theoretical formula derived from first order processes. A comparison between results in "rigid" plastic and liquid solutions aids in sorting out the processes. It is found that some solutions behave in accordance with the predictions of the theory whereas others do not. An analysis of possible reasons for the discrepancies is given. Quenching of the bulk and solute are studied by observing effects of dilutions. Quenching of the transferring substance decreases upon dilution and very likely accounts for the smaller quenching of the solute. The decrease of quenching is attributed mostly to the migration processes. In rigid media a similar study indicates that energy migration occurs in polyvinylnaphthalene and polystyrene and is as good as in liquids for the polyvinylnaphthalene. Mere closeness is found not to ensure quenching. ZnS: Cu/Cl phosphors were prepared and their relative capacity change measured. This represents the beginning of a program arrived at relating the chemical and physical conditions of preparation to the electrical properties of phosphors. Apparatus was constructed for the preparation of organic crystals by the Bridgman method. The furnace and controls are described. (For preceding period see NP-9495.) (auth)

9508 (NYO-9622) AN INVESTIGATION OF THE ANISOTROPIC LATTICE DEFECTS IN NATURAL AND SYNTHETIC QUARTZ BY FAST NEUTRON IRRADIATION. Final Report. S. E. Wisnewski, T. Imura, and S. Weissmann (Rutgers Univ., New Brunswick, N. J. Coll. of Engineering). Jan. 1961. 14p. Contract AT(30-1)-1730.

The quartz crystals investigated were: natural Brazilian; "z-growth synthetic," with growth perpendicular to basal plane; and "z-face synthetic, with growth direction perpendicular to the z-minor rhombohedron of the seed plate. The crystals received doses of 10^{19} to 10^{20} nvt. The lattice spacing measurements were made by the back-reflection divergent beam method. The maximum induced strain for the z-cut crystals was ~0.6%; whereas, for x-cut crystals it was ~1.8%. The large strains found in the x-cut crystals were reflected by the conspicuous break-up of the x-ray line profile into multiple peaks, which is characteristic of a substructure formation. The maximum strain for the z-cut crystals was perpendicular to the c-axis while it varied somewhat for the x-cut crystals. The minimum strain for z-cut crystals was parallel to the c-axis; whereas, that of the x-cut crystals was perpendicular. An irradiation defect mechanism was proposed from a study of the x-ray line profile intensity distribution. (B.O.G.)

9509 (TID-6952) DEAGGLOMERATION OF KAOLIN BY HIGH-ENERGY, IONIZING RADIATION. Annual Technical Status Report No. 1 Covering the Period 1 April 1959 to 31 March 1960. William J. Corbett and John H. Burson, III

(Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Apr. 20, 1960. 36p. Project No. A-446-5. Contract AT(38-1)-202. Task No. V, Contract Authorization No. 1A-59-43.

The objective of this research program is to investigate the possibilities of using high-energy ionizing radiation to reduce agglomerates of kaolin plates to discrete particles. Samples of a well-crystallized kaolin from Washington County, Georgia, were subjected to both x and γ radiation. The results of physical tests made on the samples irradiated with the γ research irradiator and a sample given a total energy dose of 1×10^{21} ev per gram with a 150-kv x ray machine indicate that kaolin stacks can be deagglomerated with high-energy ionizing radiation. The data from x-ray-diffraction studies show a definite decrease in the degree of crystallinity for kaolin subjected to high-energy ionizing radiation. Research in the immediate future will be concerned with further evaluation of the samples irradiated to date, particularly with respect to particle size, reflectance, and electron-diffraction studies. In view of some of the results contained in this report, grinding studies of kaolin before and after irradiation have become of prime importance. These studies will begin early in the next year. Future experiments will be designed to obtain more information as to the processes that take place when kaolin is subjected to high-energy ionizing radiation. (auth)

9510 (TID-6953) DEAGGLOMERATION OF KAOLIN BY HIGH-ENERGY, IONIZING RADIATION. Quarterly Technical Status Report No. 4, Project No. A-446-5, Covering the Period April 1, 1960 to June 30, 1960. William J. Corbett and John H. Burson, III (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). July 10, 1960. 16p. Contract AT(38-1)-202 Task No. V.

Research performed on this project during the period covered by this report has been concerned with particle-size distributions, reflectance measurements, infrared absorption studies, and cation-exchange measurements of kaolin before and after irradiation. Grinding studies were conducted with both irradiated and unirradiated kaolin, and the results are evaluated by particle-size determinations, x-ray-diffraction measurements, and electron microscopy. The particle-size distributions obtained give further evidence that the size of kaolinite stacks can be reduced by gamma radiation. The light reflectance of kaolin is slightly reduced by irradiation. The results of infrared absorption measurements show no significant changes in the basic lattice structure of kaolinite by gamma radiation. The cation-exchange capacity of the kaolin used in these studies appears to be significantly affected by gamma radiation, although no conclusive trend can be observed at present. Dry grinding of an unirradiated and an irradiated kaolin shows that the irradiated kaolin grinds more easily. (auth)

9511 (TID-11057) RADIATION DAMAGE STUDIES IN SOLIDS; NUCLEAR RESONANCE ABSORPTION TECHNIQUE. Progress Report for Period covered: November 1, 1959 to November 1, 1960. P. J. Bray (Brown Univ., Providence). Nov. 1, 1960. 15p. Contract AT(30-1)-1880.

Nuclear magnetic resonance (NMR) studies, coupled with electron-spin paramagnetic resonance (ESPR) experiments, on crystals of neutron-irradiated LiF show that there are three successive total neutron-flux intervals in which different types of irradiation effects are observed. ESPR data indicate that the number of electron spins produced by the irradiation grows proportionally to the neutron flux up to 10^{18} nvt, above which the spin concentration saturates. Above 10^{18} nvt the NMR studies show that the intensity of the narrow fluorine line (attributed to gas formation) grows proportionally to the flux up to 10^{19} nvt, where it saturates. Above 10^{19} nvt the lithium metal NMR absorption line becomes observable. It is concluded that the lithium metal ions collect in clusters to form colloids of substantial size within the crystal. Theoretical studies are now being conducted to determine the size and nature of these formations. Similar experiments performed on heavily irradiated NaF do not show any observable gas or metal NMR absorption lines. This is contrary to calculations which predict sufficient gas formation for NMR detection. At the present time, other NMR methods of measuring the irradiation effects are being employed. Final measurements of different alkali-halide series are now being conducted. These series include the lithium halides, LiI, LiCl, and LiBr; the alkali iodides, KI, NaI, and LiI; and the alkali bromides, LiBr, NaBr, and KBr. Preliminary studies of conductive materials such as semiconductors and metals were completed, and irradiation programs are being undertaken. (auth)

9512 (TID-11587) THE DIPOLE MODE OF MINORITY CARRIER DIFFUSION, WITH REFERENCE TO DISORDERED REGIONS INDUCED IN SEMICONDUCTORS BY PILE IRRADIATION. (Cover carries title: RADIATION EFFECTS IN SOLIDS). B. R. Gossick (Arizona State Univ., Tempe). July 1960. 16p. Contract AT(11-1)-715.

A discussion is given of the electrical properties of n type germanium containing disordered regions that applies to other semiconductors which change type under neutron bombardment. The relations given are: electrical conductivity by minority carriers, including field and frequency dependence; and current density and Hall coefficient for both carriers. (B.O.G.)

9513 (TID-11591) RADIATION EFFECTS IN SOLIDS. Report for the Period April 1, 1960–March 31, 1961 and Request for Renewal for the Period April 1, 1961–March 31, 1962. J. G. Fox (Carnegie Inst. of Tech., Pittsburgh). Jan. 30, 1961. 30p. Contract AT(30-1)-1828.

Measurements were made of X ray induced imperfections in sodium chloride crystals and lithium fluoride crystals at low temperatures. In magnetic resonance experiments, paramagnetic defects in CaF_2 single crystals were investigated by examination of the microwave absorption spectra. Additional experiments on proton-irradiated effects on copper were conducted. Techniques for using ion emission microscopes were further developed. (J.R.D.)

9514 (WAPD-P-244) THE CONDUCTIVITY CHANGE IN GOOD INSULATORS DURING γ-IRRADIATION. III. F. R. DeFalco, S. Mayburg, and W. F. Witzig (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Sept. 25, 1952. Decl. July 13, 1960. 9p. Contract AT(11-1)-GEN-14.

The conductivity of 100 ft of polyethylene Amphenol RG-58U co-axial cable was measured during irradiation as a function temperature in the range room temperature to 90°C. A thin film of Mylar 0.002 in. thick was used to study the dependence of the conductivity on intensity of this material. Results on this material are not satisfactory as on polyethylene because Mylar seems to change with time from one series of measurements to the next. (W.L.H.)

9515 EFFECT OF THE DOSE RATE DURING THE γ IRRADIATION OF NaCl. George Ionescu. Acad. rep. populare Romîne, Inst. fiz. atomică şi Inst. fiz., Studii cercetări fiz., 11: 735-44(1960). (In Romanian)

The results of investigations made by an optical method on the effect of the dose rate on NaCl crystals irradiated by γ rays are reported. The results obtained agree with those published by Nowick for a dose rate of 191,000 r/hr.

It is shown that the number of color centers increases as a function of time and follows a law of the form $N = N_\infty(1 - e^{-\lambda t})$. The dependence of λ on the dose rate for saturation is given by the formula $\lambda_\infty = 2.7 - {}^{13}/_{14} \log (d/4000)$. From a consideration of the dependence of N on the dose rate, the NaCl crystal is not recommended for γ dosimetry. (tr-auth)

9516 DAMAGE IN UO_2 FILMS AND PARTICLES DURING REACTOR IRRADIATION. T. K. Bierlein and B. Mastel (General Electric Co., Hanford Atomic Products Operation, Richland, Wash.). J. Appl. Phys., 31: 2314-15(Dec. 1960). (HW-SA-1950)

The effects of reactor radiation in the range 10^{16} to 4.4×10^{19} nvt on thin UO_2 films and UO_2 particles dispersed in thin aluminum films were studied with transmission electron microscopy and electron diffraction. The irradiations were carried out on samples in air and in evacuated capsules. For UO_2 films of 100 A thickness, regions tend to migrate with increasing exposure to form isolated outgrowths of dense, smooth form in vacuum and of flocculent form in air. For UO_2 particles of 1 to 2 μ diameter in aluminum films, no evidence of UO_2 condensation was found for irradiation in vacuum, whereas for air, condensation was observed for exposures above 5×10^{17} nvt. At higher exposures (4.4×10^{19} nvt), the original particles were replaced by flocculent crystals which are similar to those formed in irradiation of UO_2 films in air. (D.L.C.)

9517 FISSION FRAGMENT DAMAGE IN NONFISSIONABLE THIN FILMS. T. K. Bierlein and B. Mastel (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). J. Appl. Phys., 31: 2315-16(Dec. 1960). (HW-SA-1951)

Fission fragment damage in thin films of nonfissionable materials was studied using transmission electron microscopic and shadowing techniques. Multilayered films containing regions free from UO_2 were prepared by evaporating or sputtering the material onto a carbon substrate, spraying with a suspension of polystyrene latex spheres, and shadow coating with UO_2 at an angle of 15°; the regions behind the spheres contain no fissionable UO_2. Multilayered films consisting of UO_2-Pt-C and UO_2-ZrO_2-C layers were irradiated to a thermal neutron exposure of 2×10^{16} nvt and then examined. For UO_2 – Pt – C, perforated ridges were observed for the tracks in the UO_2-free regions. For UO_2 – ZrO_2 – C, the tracks are more uniform and have a high electron transmission, but shadowing revealed nodular imperfections superimposed on the tracks. (D.L.C.)

9518 THE EFFECT OF QUENCHING AND NEUTRON IRRADIATION ON INTERNAL FRICTION OF ALUMINUM-5% MAGNESIUM ALLOY. W. G. Nilson (International Nickel Co., Inc., Bayonne, N. J.). Can. J. Phys., 39: 119-32 (Jan. 1961). (AECL-701)

Low-frequency internal friction data were obtained on the alloy Al-5% Mg to determine the effects of quenching and neutron irradiation on solute movement. A damping peak near 150°C, attributed to stress-induced reorientation of solute atoms, was found to be shifted to lower temperatures by these treatments. This behavior corresponds to a reduction in relaxation time for the damping process, and is compatible with the idea that the solute atoms act as traps for vacancies. (auth)

9519 THE EFFECT OF RADIATION DAMAGE ON THE THERMAL CONDUCTIVITY OF SUPERCONDUCTORS. K. D. Chaudhuri (Clarendon Lab., Oxford), K. Mendelssohn, and M. W. Thompson. Cryogenics, 1: 47-8(Sept. 1960).

The effects of neutron irradiation at 30°C on the thermal conductivity of niobium and vanadium single crystals were investigated at low temperatures. Measurements were carried out in both superconducting and normal states where conduction is due predominantly to phonons and electrons, respectively. The observed effect on the phonon conductivity indicates an increase in the dislocation density whereas changes in electron conduction revealed the presence of vacancies. (auth)

9520 RESPONSE OF ANTHRACENE TO β-RAYS. I. Řezanka and J. Frána (Czechoslovak Academy of Science, Prague). Czechoslov. J. Phys., 10: 686-7(Sept. 1960). (In English)

The scintillation characteristics of anthracene crystals were investigated at 30 to 400 kev using a Cs^{137} source in conjunction with a β spectrometer. The dependence of the pulse distribution maximum position on the electron energy can be approximated by a straight line that intersects the energy axis at 8.5 kev from the origin. The dependence of the square of the reduced distribution width on electron energy is also approximated by a straight line. The pulse distribution of 300-kev electrons is shown. (B.O.G.)

9521 STUDY OF THE PROPERTIES AND STRUCTURE OF METALS AND SOME STEELS IRRADIATED WITH FAST NEUTRONS. Sh. Sh. Ibragimov (Sc. Sc. Ibraghimov), V. S. Lyashenko (Liascenko), and A. I. Zav'yalov (Zavialov). (Translated into Italian from At. Energ., 8: 413-19(1960)). Ing. nucleare, 3: 170-6(July-Aug. 1960).

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9522 THE EFFECTS OF RADIATION ON MATERIALS. PART 3. RADIATION DAMAGE MECHANISMS: INSULATING MATERIALS. V. J. Linnenbom (Naval Research Lab., Washington, D. C.). Insulation, 6: No. 3, 11-15 (Mar. 1960).

Behavior of electrical insulation in a radiation field was considered from two viewpoints: temporary phenomena observed during irradiation, which depend largely on dose rate, and permanent effects that persist after removal from the field, which usually depend on total dose. Both organic and ceramic type materials showed increased conductivity and current leakage when exposed to radiation. Most of the induced conductivity disappeared within a short time after the irradiation ceased. With organic insulators, the permanent radiation damage was usually more of a problem than the transient effects. Inorganic insulation materials suffered far less permanent damage than the organic. The following materials are listed in order of decreasing radiation stability: ceramics, mica, glass, polystyrene, "Mylar," polyethylene, "Lucite," silicone rubber, nylon, and "Teflon." The effects of temperature, humidity, and the presence of surrounding gases during irradiation are discussed. (M.C.G.)

9523 PARAMAGNETIC STUDIES OF RADIATION DAMAGE IN SILICA GEL. Harold W. Kohn (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 33: 1588(Nov. 1960).

Several paramagnetic resonances and a color center in irradiated silica gel are reported. Irradiations were carried out using a Co^{60} source of ~700 curies. At the ambient irradiation temperature of ~50°C, a very sharp paramagnetic resonance is produced at a spectroscopic splitting factor of $g = 2.0005 \pm 0.0005$, which is only a few gauss in width. The resonance displays some g anisotropy seen as a slight shoulder on the low-field side, it is easily saturated at low power, and is not greatly changed by cooling to −196°C. The maximum radiation yield for production of this line is ~0.1 center/100 ev absorbed. The irradiation

of degassed silica gels at −196°C produces a second, somewhat broader line immediately on the low-field side of the first line. This line could not be saturated with microwave power and is unaffected by added gases when kept cold. Brief warming of the sample destroys the line. Additions of oxygen to gels irradiated at −196°C causes the slow appearance of an orange color, but leaves the PMR spectrum unaffected. If oxygen is present during the low-temperature irradiation, both a marked reddish-orange and a third, very strong, broad resonance at g = 2.0061 ± 0.001 are developed. The radiation yield G is ~0.3 center/100 ev absorbed. The sharp resonance at g = 2.0005 probably arises from an electron trapped at an oxygen vacancy, because it disappears upon oxygen absorption at 25°C. The very broad resonance at g = 2.0061 appears to be a radiolysis product of a condensed oxygen phase stabilized by adsorption on the gel. (B.O.G.)

9524 RADIATION HARDENING OF COPPER SINGLE CRYSTALS. T. H. Blewitt, R. R. Coltman, R. E. Jamison, and J. K. Redman (Oak Ridge National Lab., Tenn.). J. Nuclear Materials 2: 277-98 (Dec. 1960). (In English)

The effect of nuclear radiation on the mechanical properties of copper was studied. It was found that the yield stress, which is substantially increased by the radiation, increases as the cube root of the flux. A strong temperature dependence of the yield stress of irradiated copper was observed with the yield stress being given by a function similar to $\sigma = A - BT^{\frac{1}{2}}$ above 40°K. A Lüders band with slip lines of very large step height was associated with the enhanced yield stress at small strains. At large strains the phenomenon of overshoot was observed. The annealing kinetics of the radiation hardness were also studied in the temperature range from 25 to 700°K. Little or no annealing was observed in the region below 80°K. In the region from 80 to 300°K, approximately 20% of the yield stress was recovered, with the remainder annealing in the range from 600 to 700°K. These results are discussed in terms of the possible mechanisms by which the hardening can occur. While by no means conclusive, these data support a dislocation locking mechanism. On the other hand a very close analogy exists between radiation hardening and the hardening which arises from the addition of impurities, e.g., the hardening in α brass. The correlation between work hardening and radiation hardening appears to be quite small. (auth)

9525 NEUTRON IRRADIATION OF GRAY TIN. A. N. Goland (Brookhaven National Lab., Upton, N. Y.). Phys. and Chem. Solids, 16: 46-52(1960). (BNL-4503)

Gray tin was irradiated at 0°C in a reactor in an effort to produce white tin as a result of localized heating caused by thermal spikes. The irradiated powder was compared to an unirradiated specimen by means of x-ray studies at low temperatures. No significant change was found in the amount of white tin present as a result of irradiation. The implications of this result for the thermal-spike concept are discussed and various explanations for the experimental results are offered. (auth)

9526 ENERGY DISSIPATION AND SECONDARY ELECTRON EMISSION IN SOLIDS. H. Kanter (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 121: 677-81(Feb. 1, 1961).

Experimental evidence is presented for the proportionality between secondary electron yield and the energy dissipated by electrons near the surface of a solid. Using measurements of the energy carried away by electrons transmitted and reflected from thin foils of aluminum and carbon, the energy dissipated in an incremental layer at the exit surface was obtained. Simultaneous measurements of the secondary electron yield showed a close proportionality between the number of secondaries produced and the energy dissipation density near the surface independent of the incident electron energy between 1 and 10 kev. By subtracting the contribution of the backscattered electrons to the yield at the front surface of a thick aluminum target, the yield of secondaries was found to be proportional to the rate of energy loss calculated from the Bohr-Bethe theory over the energy range investigated. (auth)

9527 CONTRIBUTION OF BACKSCATTERED ELECTRONS TO SECONDARY ELECTRON FORMATION. H. Kanter (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 121: 681-4(Feb. 1, 1961).

It is shown experimentally that backscattered electrons emitted from solids under electron bombardment contribute significantly to the observed secondary yield, even for the case of low backscattering coefficients. Thus, it was found that in aluminum with a backscattering coefficient of only 0.14, about 40% of all secondaries are produced by backscattered electrons for initial energies from several kev to several tens of kev. The large contribution of backscattered electrons to secondary formation even for materials of low atomic number agrees approximately with what one would expect from the larger rate of energy loss and the greater path lengths of the backscattered electrons in the secondary electron escape region compared to that of the incoming primaries. (auth)

9528 THERMODYNAMIC GREEN'S FUNCTION METHODS IN NEUTRON SCATTERING BY CRYSTALS. Gordon Baym (Harvard Univ., Cambridge, Mass.). Phys. Rev., 121: 741-7(Feb. 1, 1961).

Formulas were derived for the transition probabilities per unit time for both inelastic coherent scattering of neutrons by crystals and resonant emission of photons and neutrons by nuclei bound in crystals, without making the assumption that the crystal is harmonic. In deriving these transition probabilities, the analytic structure of thermodynamic correlation or Green's functions, considered as functions of complex temperatures and times, was developed and used. In particular a spectral form was found for the phonon Green's function. Only one assumption was made about the crystal, namely that the displacement of the nuclei due to the forces exerted by the neutron in scattering are linear functions of these forces. This led to an evaluation of the transition probabilities in terms of the exact thermodynamic displacement autocorrelation function. This evaluation obeyed the detailed balancing condition, and Placzek's sum rule. A consequence of this evaluation is that the widths of the "one-phonon" peaks in the neutron scattering are exactly equal to the widths of the corresponding phonon states of the crystal. (auth)

9529 PROPERTIES OF GRAPHITE. PART III—CRYSTAL COMPOUNDS AND IRRADIATED GRAPHITE. L. C. F. Blackman (Imperial Coll. of Science and Technology, London, England). Research (London) 13: 492-502 (Dec. 1960).

Crystal structure, electronic properties, and chemical bonding of graphite lamellar compounds are reviewed. The production of analogous structures in irradiated graphite is discussed. (C.W.H.)

9530 THE EFFECT OF FAST-ELECTRON BOMBARDMENT ON THE ELECTRICAL CONDUCTIVITY OF SILICON AND THE DEPENDENCE OF THE RATE OF DEFECT FORMATION ON THE ORIENTATION OF A CRYSTAL WITH RESPECT TO THE ELECTRON BEAM. V. S.

Vavilov, V. M. Patskevich, B. Ya. Yurkov, and P. Ya. Glazunov (Lebedev Inst. of Physics, Moscow). Soviet Phys.-Solid State, 2: 1301-3(Jan. 1961).

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9531 RADIATION DEFECTS IN CRYSTALS. L. S. Smirnov (Lebedev Inst. of Physics, Moscow). Soviet Phys.-Solid State, 2: 1512-13(Jan. 1961).

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9532 THE INFLUENCE OF TRAP LEVELS ON THE RELAXATION OF THE NONEQUILIBRIUM CONDUCTIVITY OF GERMANIUM IRRADIATED WITH γ-RAYS. S. M. Ryvkin and I. D. Yaroshetskii (Inst. of Physics and Tech., Academy of Sciences, Leningrad). Soviet Phys.-Solid State, 2: 1771-80(Feb. 1961).

A study was made of the temperature dependence of the relaxation of the nonequilibrium conductivity of samples of n-Ge irradiated by γ quanta. The following results were obtained. (1) The position of the recombination levels corresponding to defects produced by the irradiation was determined, as well as the trapping section for holes on these levels at room temperature. (2) In addition to recombination levels, the defects produced by γ radiation form in n-Ge levels which play the role of trap levels in certain conditions. (3) The constant of decay of nonequilibrium conduction in the region where the relaxation curve is exponential is determined in irradiated samples both by the recombination lifetime and by the parameters of the trap levels. (4) The values of the trapping coefficient for holes and electrons on centers playing the role of trap levels have been determined, as well as their location in the forbidden band; it has been shown that these levels should be described as vacancies. (5) At low temperatures the cohesion levels are transformed into recombination levels, which also determine recombination in irradiated n-Ge. (auth)

9533 FURTHER RESEARCH ON THE EFFECTS OF RADIATION ON METALS. Erich Schmid and Karl Lintner (Univ., Vienna, Austria). Z. Metallk., 51: 615-20(Nov. 1960). (In German)

The advantages of the application of α irradiation for following radiation effects in metals are represented by several examples. By simultaneous investigation of the conductivity and Hall effect of α-irradiated aluminum and copper, an effort was made to trace the resistivity variations back to changes in the concentration and mobility of charge carriers. The question of an orientation dependence of the α-induced resistivity increase was tested by research on zinc crystals of very different orientations. A remarkable anisotropy was observed for which interpretations were discussed. The α-induced change of the transition point for the appearance of superconductivity in white tin is remarkably large. It greatly surpasses, for a given concentration of perturbation sites, that observed in zinc mixed crystals of the same concentration in foreign materials. The question of an effect on the austenite-martensite transformation by neutron bombardment was followed on a chromium steel. From critical doses up, an activation of the transformation was observed which overlies, at higher doses, a stabilization effect of the residual austenite. (tr-auth)

9534 IMPROVEMENTS IN PROCESSES FOR MODIFYING THE PROPERTIES OF TYPE IIb DIAMONDS. (to Industrial Distributors Ltd.). French Patent 1,195,862. May 19, 1959.

Methods for improving the color and increasing the specific resistivity of semiconducting diamonds consist in irradiating the diamonds with either 0.5 to 0.9-Mev γ photons; 1-Mev electrons; utilizing a flux of 2.10^{16} electrons/cm^2 and a current density of 4 mA/cm^2; or pile neutrons during 45 min. (NPO)

PHYSICS

General and Miscellaneous

9535 (AD-239449) PULSED OPERATION OF A PLASMA PISTON TUBE. Richard H. Huddlestone (Space Technology Labs., Inc. Physical Research Lab., Los Angeles). Apr. 7, 1960. 10p. Contract No. AF 04(647)-309. (STL/TN-60-0000-09067)

One method for using plasma as a propellant in a propulsion system envisions an electromagnetic field moving down a transmission line and generating plasma thereby. To realize cyclic operation and high efficiency in such a scheme, it is necessary to recover a large part of the energy invested in the piston field during each cycle. A simplified model problem chosen to illustrate one possible recovery technique is discussed. The model involves pulsed operation of a rail-geometry line with the plasma represented as a moving short. It is shown that by proper timing of the piston, the recovery efficiency is limited only by resistive losses. (auth)

9536 (ANL-6199(p.6-15)) PROBABILITY OF IONIZATION IN ENERGY TRANSFER FROM EXCITED ATOMS TO MOLECULES. Robert L. Platzman.

The probability that a molecule is ionized when it acquires excitation energy in excess of its ionization potential in a collision with a metastable helium, neon, or argon atom is deduced for fourteen diatomic and polyatomic molecules from measurements of the total ionization by α particles in contaminated noble gases. In every case this ionization efficiency is smaller than unity, and in some it is much smaller. In a few instances, the results can be compared with the corresponding probabilities in excitation by absorption of light, and the two ionization efficiencies are found to be equal within the uncertainties of the data. Some of the implications of these results are discussed. (auth)

9537 (ARL-TN-60-119) SOME APPLICATIONS OF THE POISSON DISTRIBUTION. Z. N. Loh (Wright Air Development Center. Aeronautical Research Lab., Wright-Patterson AFB, Ohio). Aug. 1960. 31p. Project No. 7073.

A brief summary of the formula and use of the Poisson distribution is given. The introductory remarks are concerned with the meaning of the stochastic processes as a model of statistical processes and the special aspects of these devices. The Poisson distribution $P(n) = (e^{-t}t^n)/(n!)$ is known as an approximate exponential function which expresses the probability of random rare events. It also can be derived as the limiting case of the binomial distribution. In the tables, numerical values were calculated for small values of n and t, and graphs were drawn by connecting the points corresponding to the small values of t for specific values of n. The smooth curves show the approximations. The use of the Poisson distribution function is illustrated in special examples, namely, light emission or absorption, and in connection with the theory of cosmic-ray showers. (auth)

9538 (KAPL-M-MAG-4) MANUFACTURE AND CALIBRATION OF NR PRIMARY PHYSICAL STANDARDS FOR ALPHA COUNTING. Michael A. Gerardi (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 5, 1960. 12p.

The procedures used to manufacture and calibrate alloy standards of natural uranium in zirconium for use in α counting are described. Results obtained from the calibration of the standards are also presented. Seven sets of primary physical standards, to be used to calibrate α count equipment, were prepared. (auth)

9539 (MND-P-2369) CONCEPTUAL DESIGN OF A SNAP III TYPE GENERATOR FUELED WITH CERIUM-144. Robert J. Wilson (Martin Co. Nuclear Div., Baltimore). June 1960. 48p. Contract AT(30-3)-217.

A design concept is presented for an electrical system using two SNAP III type generators fueled with cerium. In the modified SNAP III generator, a capsule of Haynes 25 contains 9725 curies of cerium oxide pellets, which will provide 67 thermal watts at time of launch. Sufficient void volume and capsule strength ensure containment of the oxygen evolved through isotope decay during the operational life of the generator. Thermal converter configuration in the conceptual generator is identical to that of the SNAP III except that the shell is stainless steel. Two methods of biological shielding are considered. The first uses mercury contained in a sphere surrounding the generator. In the second concept, a lead cask shields the unit until its installation in the launch vehicle. A remote installation procedure and an equipment arrangement are proposed. Generator output predictions were based on actual test data. The output of a single unit would be 3.8 watts at launch, decreasing to 1.9 watts in the course of a 6-month mission. A ground-handling procedure and conceptual designs of the equipment are included. (auth)

9540 (NP-9501) REPORT NO. MR 20,093 ON MAGNETO GASDYNAMIC CHANNEL FLOW. Artur Mager (Marquardt Corp., Van Nuys, Calif.). April 1960. 55p.

The results of an analytical investigation into the implied limitations of the quasi-one-dimensional magnetogasdynamic channel analysis are presented. For this purpose a set of self-consistent one-dimensional solutions is obtained and discussed in terms of the supersonic accelerator performance. It is shown then that these solutions logically indicate a set of constraints which need be imposed on the more approximate, but also more useful, channel analysis. Their role is to ensure that the electromagnetic body forces act primarily in the streamwise direction. The so constrained channel flow solutions result in definite limitations on the maximum velocities which may be obtained in an accelerator. Consequently, in general, they must eventually lead to substantial disagreement with other solutions of the channel theory where such limitations do not exist. However, under certain special conditions, and for not too large a channel length, the constrained solutions are shown to agree reasonably well with the constant static temperature solutions. (auth)

9541 (NP-9679) QUARTERLY PROGRESS REPORT NO. 59. J. B. Wiesner, G. G. Harvey, and H. J. Zimmermann (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). Oct. 15, 1960. 190p. Contract DA36-039-sc-78108.

Research activities are reviewed in the fields of physical electronics, plasma dynamics, solid-state physics, microwave spectroscopy, nuclear magnetic resonance and hyperfine structure, microwave electronics, molecular beams, satellite time-dilation measurement, stroboscopic research, modulation theory and systems, statistical communication theory, processing and transmission of information, physical acoustics, speech communication, communications biophysics, neurophysiology, circuit theory, noise in electron devices, linguistics, and sensory aids. (For preceding period see NP-9307.) (W.D.M.)

9542 (NP-9697) ON THE IONIZATION OF MOLECULAR GASES BY BETA PARTICLES. W. Kołos (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). September 1960. 12p.

Qualitative results were obtained which show that the average energy required to produce an ion pair by β particles should be greater for diatomic gases than for those composed of free atoms. The hydrogen molecule is used as an example, and the results obtained account for the discrepancy between the theoretical values for free atoms and the experimental ones for the molecule. (auth)

9543 (NP-9711) ORBITAL THEORY IN THE TRANSITION METALS. W. R. Trost (Canada. Dept. of Mines and Technical Surveys). Aug. 20, 1958. 77p.

Orbital constructions and electron populations are worked out for the bands in the transition metals. Within the framework of the method it is possible to predict the lattice elected by the elements. Manganese and iron are exceptions, and α-Fe is treated as a special case. Numerical values for electron populations in the several s,p,d, and hybrid bands, including their bonding, antibonding, and nonbonding levels, are obtained. Chemical reactions, in which binary compounds are formed, appear from specified interorbital reactions. Transition metal alloys (d,s,p vs. d,s,p), intermetallic compounds (d,s,p vs. s,p), and interstitial compounds ((n-1)d,ns,np vs. 2s, 2p) are considered. Lattice-composition relationships and band populations are obtained. The properties of the populated bands are shown to have a correspondence with some of the physical properties of the elements and compounds. Numbers are obtained for the residual and saturated moments and for the Curie point in α-Fe. (auth)

9544 (NP-9813) ION AND ATOMIC BEAMS IN SPACE. Third Semi-Annual Report, July 1–December 31, 1960. Robert L. Carroll and J. M. Cerceo (American Machine and Foundry Co. Advanced Research Dept., Alexandria, Va.). Jan. 20, 1961. Contract DA-36-039SC-78961. 33p.

A study was made of the possibility of using the intermediate process of ionization of the atmosphere at high elevation for communication with a ground station. The method is not recommended because of the large mass density and power required in the beam. The formation of a neutral beam by a recombination of ions held in circular paths and which are tangentially coincident was studied. It is felt that this method is sufficiently feasible to merit further investigation in the application to propulsion as well as to communication. In conjunction with this study, a fairly extensive survey and analysis of the recombination coefficient under various conditions was made. An investigation of the pinch effect as applied to charged beams in the atmosphere indicated that relatively enormous currents were required and that the pinch was unstable under all conditions of generation. The conclusion was reached that this effect was not applicable to the problem of limiting the spread of a beam over any appreciable distance in the upper atmosphere. Power requirements to maintain ionization over any reasonable distance of transmission are quite high. (auth)

9545 (NRL-Memo-1089) STATUS REPORT ON THERMOELECTRICITY. J. W. Davisson and Joseph Pasternak (Naval Research Lab., Washington, D. C.). Aug. 1960. 64p.

After a survey of progress on thermoelectric materials

development, properties of materials are given. The data include: Seebeck coefficients of principal borides, carbides, nitrides, and silicides of transition metals; thermoelectric efficiencies of Co–Fe–Si and Cr–Mn–Si compounds; Seebeck coefficient and resistivity of Cr–Si, Cr–Mo–Si, Gd bismuthides, Gd antimonides, Gd silicides, Gd phosphides, and Gd selenides; Seebeck coefficients for Hf borides and silicides; Seebeck coefficient and resistivity of Li_2O–NiO and Li_2O–CoO; electrical properties of 10 AlAs–90 GaAs alloys at room temperature; x-ray-diffraction analysis and electrical properties of $CuGaS_2$, $AgGaS_2$, $CuGaTe_2$, $AgGaTe_2$, $CuGaSe_2$, and $AgGaSe_2$; room-temperature electric properties of cast $CuGaTe_2$; and Seebeck coefficient and resistivity of cuprous sulfide. The Westinghouse 5-kw experimental thermoelectric generator is described. Research contracts are outlined. An appendix on thermal conductivity of solids at high temperatures is included. (T.R.H.)

9546 (ORNL-2966) DISSOCIATION OF H_2^+ BY HYDROGEN. H. Postma and D. P. Hamblen (Oak Ridge National Lab., Tenn.). Dec. 13, 1960. 13p. Contract W-7405-eng-26.

The dissociation cross section of H_2^+ by hydrogen was measured at 200 through 600 kev. An H_2^+ beam incident upon a differentially pumped hydrogen gas target was electrostatically analyzed for H_2^+ and the H^0 and H^+ dissociation products. The charged particles were detected by a Faraday cup and the neutral particles by a secondary-electron-emission collector. The measured total loss cross section (in cm^2 per gas atom) for H_2^+ was 7.80×10^{-17} at 200 kev, 5.81×10^{-17} at 300 kev, 4.95×10^{-17} at 400 kev, 4.52×10^{-17} at 450 kev, 4.09×10^{-17} at 500 kev, and 3.86×10^{-17} at 600 kev. The measured proton production cross section (in cm^2 per gas atom) was 9.53×10^{-17} at 200 kev, 7.80×10^{-17} at 300 kev, 6.61×10^{-17} at 400 kev, 6.65×10^{-17} at 450 kev, 6.42×10^{-17} at 500 kev, and 6.03×10^{-17} at 600 kev. Both the total loss cross section for H_2^+ and the proton production cross section are in close agreement with the results reported by Sweetman for energies 200 through 500 kev, and with the results reported by Barnett for energies 500 through 600 kev. (auth)

9547 (PIBMRI-806-60) THEORETICAL AND EXPLORATORY EXPERIMENTAL RESEARCH IN ELECTROMAGNETICS, NETWORKS AND RELATED SOLID STATE, AND PLASMA TOPICS. Final Report. N. Marcuvitz (Brooklyn. Polytechnic Inst. Microwave Research Inst.). June 1, 1960. 95p. Contract AF19(604)-4143. (AFCRC-TR-60-161).

Sections dealing specifically with anisotropic discontinuities, statistical investigations of plasmas, plasma diagnostics, diffraction, bunching of charged particles, a novel ion pump, and thin films are included. (auth)

9548 (RM-2610(AEC)) SOME STATISTICAL PROPERTIES OF LEVEL AND LINE DISTRIBUTIONS IN ATOMIC SPECTRA. S. A. Moszkowski (RAND Corp., Santa Monica, Calif.). Nov. 8, 1960. 69p. Contract AT(29-1)-1477.

Properties of the resulting level and line spectra (or distributions) were investigated, statistically. It is shown that the first and second moments of the spectra (weighed by the appropriate statistical weight factors) vary in a regular way with the number of particles in the shell, the second moment reaching a maximum in the middle when the shell is about half full. The detailed shape of the distribution, called the "strength function," is investigated using simplified models. If only close-together single-particle orbits are mixed by the interactions (which is the situation usually assumed in shell model type calculations) then the strength function for levels is essentially exponential and that of lines somewhat like a Gaussian. (auth)

9549 (TID-11005) NUCLEAR PHYSICS LABORATORY PROGRESS REPORT FOR THE PERIOD NOVEMBER 1, 1959 TO OCTOBER 31, 1960. (Case Inst. of Tech., Cleveland. Nuclear Physics Lab.). 45p. Contract No. AT(11-1)-720.

Experimental Research–Betatron Group. Experiments to clarify the photoproton processes in Li^6 by direct observation of the proton energy spectrum versus betatron energy are described. Data taken between 18 and 20.5 Mev show a peak for a 5-Mev proton. As betatron energy increases, the peak strength increases. No such anomaly is observed with Li^7. A Cherenkov beam monitor for the betatron is described which consists of a lucite strip coupled to a photomultiplier. A 100-kv pulsed vacuum spark x-ray source was completed. Experimental Research–Van de Graaff Group. Operation and instrumentation of the Van de Graaff accelerator are summarized. Nuclear resonant absorption was used to determine the total width, the radiation width, and the proton width for a previously unreported level at 10.3 Mev in Ca^{40}. A pulsed-beam time-of-flight experiment was performed in good geometry to measure the total cross sections for U^{235} and U^{238} at 0.5- to 1.0-Mev neutron energy. The results are about 1% higher than previously published. The differential elastic neutron scattering cross sections were determined for F^{19} at 565 and 1000 kev, using a time-of-flight technique. Inelastic scattering angular distributions were obtained for 565-kev neutrons. The differential scattering cross sections for 0.71- and 0.90-Mev neutrons elastically scattered from C^{12} were measured by time-of-flight, and the differential elastic and inelastic scattering cross sections for excitation of the 0.133- and 0.303-Mev levels in Ta^{181} were measured for 0.71- and 0.90-Mev neutrons. Development of instrumentation for $(n,n'\gamma)$ angular correlation measurement is described. A neutron polarization analyzer using He^4 was designed and built. Progress in the pulsing modification of Van de Graaff is reported. Theoretical Research Program. Work on Li^6 structure was extended by variational calculations based on a wave function for Li^6 consisting of an antisymmetrized product of a wave function for the 4-core nucleons and a wave function for the two extra-core nucleons. The problem of writing a given antisymmetric function in n variables as a Slater determinant of n one-variable functions was solved, using methods based on the theory of mappings of linear vector spaces. It is suggested how shaping the r-f voltage in synchronous accelerators can expand the range of phase stability. It was found that vacuum polarization has no effect on the rate of astrophysical $p + p \rightarrow H^2$ reactions. (T.R.H.)

9550 (TID-11017) THERMAL AGITATION AND TURBULENCE. R. Betchov (Space Technology Labs., Inc. Physical Research Lab., Los Angeles). August 18, 1960. 23p. Contract AT(04-3)-321. (STL-TR-60-0000-AE279).

A study was made to clarify the relation between turbulence and thermal agitation. Thermal agitation is the molecular processes and fluctuating forces in a range where molecular disorder produces random collective motions of all scales. Turbulence is the random motion of a fluid. The problem is treated in the language of the continuum theory. (T.R.H.)

9551 (TID-11051) NUCLEAR QUADRUPOLE ABSORPTION IN INDIUM METAL. W. W. Simmons and C. P. Slichter (Illinois. Univ., Urbana). [nd]. 44p. Contract AT(11-1)-833.

The nuclear quadrupole resonance spectrum of indium

metal was observed and studied over the temperature range 4 to 225°K. The four transition frequencies occur in ratios of 1:2:3:4, as expected from the crystal structure of indium. The lowest transition at 1.881 mc/sec (at 4.2°K) gives a quadrupole coupling constant of (45.19 ± 0.02) mc/sec. The root second moment of 18 kc/sec is substantially greater than the 4 kc/sec predicted from magnetic dipolar coupling among the nuclei, is temperature independent, but somewhat sample dependent. It is shown that for a pure quadrupole resonance, the pseudo-exchange coupling produces an exchange broadening. This mechanism is shown to contribute about 10 kc to the root second moment and predicts a Gaussian line shape, as observed. It is concluded that in some cases magnetic impurities must be present, but it is not known whether the narrowest line represents a natural width. The field gradient is computed assuming point ions and a uniform electron density by a technique that converges rapidly with distance, but the answer is too small by a factor of 3. It is argued that it is important to consider the p valence electrons. The temperature dependence of frequency is very strong (a 23% decrease between 4 and 220°K), and unexplained. It appears to show that the field gradients cannot be computed assuming point ions and a smooth charge distribution. A resonance in the superconducting state is reported. (auth)

9552 (TID-11060) BRIEF SURVEY ON GROWTH AND COLLAPSE OF STEAM BUBBLE. Ichiro Nishiwaki (Minnesota. Univ., Minneapolis). Oct. 1960. 19p. Contract AT(11-1)-926.

The general equation of motion for a spherical bubble is derived. Other equations are discussed and compared with experimental data. (T.R.H.)

9553 (TID-11067) SOLID STATE PHYSICS PROGRAM. Annual Progress Report. (Case Inst. of Tech., Cleveland). Nov. 1, 1960. 12p. Contract AT(11-1)-623.

Thin Film Physics. Progress is reported on studies of dependence of magnetization on temperature and thickness, magnetic anisotropy, stress in iron films, and domain structure in thin films. Cohesive Properties. Bulk modulus and shear constants in lithium–magnesium were measured; the results are discussed. Solid State Theory. Band-structure calculations are discussed for cesium–gold and phosphorus. Work on theoretical interpretation of negative thermal expansion coefficients was begun. (T.R.H.)

9554 (TID-11115) MONTE CARLO CALCULATION OF THE HARD SPHERE EQUATION OF STATE. Progress Report. J. D. Jacobson and W. W. Wood (Los Alamos Scientific Lab., N. Mex.). Aug. 18, 1958. 25p.

An extensive review of previous work is given preceding confirmation runs, compression runs, and delta studies. It is concluded that the hard sphere equation of state for $\tau < 1.50$ is open to question, and the interpretation in terms of a first-order phase transition in the range $\tau = 1.55$ to 1.60 is also uncertain. (T.R.H.)

9555 (TID-11643) THE SCINTILLATION PROPERTIES OF COORDINATION COMPOUNDS. Progress Report for Period Ending December 31, 1960. R. N. Keller (Colorado. Univ., Boulder). 23p. Contract AT(11-1)-261.

Major advances were made in isolating simple structural systems that possess scintillation properties. Information is presented on: scintillating properties of toluene; the extension of a quartz window phototube to the detector; and the calibration of an oxygen-free pulse-height evaluating system. The scintillation properties of a triethylamine-cyclohexane solution are discussed. Substituent groups in salicylate and anthranilate compounds were classified according to the effects of these groups on molecular resonance energy, and the wavelength of maximum fluorescence emission. (B.O.G.)

9556 (AEC-tr-4354) MIGRATION OF ENERGY IN ALKALI-HALIDE CRYSTALLOPHOSPHORS. Ch. B. Lushchik, N. E. Lushchik, G. G. Lildya, and L. A. Teiss. Translated from Trudy Inst. Fiz. i Astron. Akad. Nauk, Eston. SSR, 6: 63-80(1957).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, as abstract No. 17139.

9557 (AEC-tr-4408) A WAVELENGTH INDEPENDENT RECORDING DOSIMETER FILM. K. Becker, E. Kline, and E. Zeitler. Translated by L. L. Smith (Savannah River Lab.) from Naturwissenchaften, 47: 199-200(1960). 4p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, as abstract No. 15794.

9558 (AEC-tr-4448) SPUTTERING OF COPPER BY ION BOMBARDMENT OF 5-25 KEV (thesis). Pieter Klass Rol (Amsterdam. Universiteit). Translated for Oak Ridge National Lab. 168p. (Includes original, 75p.).

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract No. 5476.

9559 (CEA-tr-R-1100) SUR LE PROBLÈME DE LA MESURE DES POTENTIELS D'ÉLECTRODE DES RADIO-ELEMENTS. (On the Problem of Measuring Electrode Potentials of Radioelements). D. M. Ziv and G. S. Sinitsyna. Translated into French from Trudy Radievogo Inst. im. V. G. Khlopina, 8: 127-37(1958). 24p.

A method is given for determining the electrode potentials of radioelements which is an improvement over that of Hevesy and Paneth. It involves obtaining curves of deposition vs. potential and dissolution vs. potential, the latter curve intersecting the abscissa at the equilibrium electrode potential. The electrode potential for Po(metal)/Po(ion) on gold in 0.1N HCl with a polonium concentration of 10^{-10} moles/l was found to be +0.617 ± 0.002 V. (T.R.H.)

9560 (JPLAI-TR-11) CONTRIBUTION TO ION PROPULSION. Astronautics Information Translation No. 11. J-J. Barfe (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Translated by Maurice Thornton and J. L. Zygielbaum. June 17, 1960. 43p. Contract NASw-6.

The configuration and operating characteristics of an ion propulsion ejector are discussed. The ionizer and accelerator are fused into a single component. It is considered necessary to disintegrate the electrodes to the maximum by reducing them to grids or to an arrangement of tubular electrodes for the injection of ions into the accelerator field. The maximum charge on diverse particles compatible with their mechanical resistance is examined for solid particles, globules and microbubbles. Solid particles were found capable of supporting higher specific charges than liquid globules of the same dimensions. The most promising methods for ionization were found to be electrification by contact and electrification by electronic emission. The space-charge effect was found to reduce the accelerator sectional thrust per cm^2 of ions to relatively low values. Reasonable values for this unit thrust could be obtained only with accelerator fields of 100,000 to 500,000 v/cm. (C.J.G.)

9561 (TG-230-T163) SOME OPTICAL INVESTIGATIONS OF A HIGH-POWER PULSED GAS DISCHARGE IN HYDROGEN. P. S. Kireev and A. A. Iuzefovich. Translated by R. P. Illwitzer from Vestnik Moskov. Univ. Ser. Mat., Mekhan., Astron., Fiz. i Khim., 13: No. 5, 105-10 (1958). 8p.

This paper was previously abstracted from the original

language and appears in NSA, Vol. 13, as abstract No. 20428.

9562 (UCRL-Trans-456) INFLUENCE OF A SENSITIZING SOLUTION ON THE RECRYSTALLIZATION OF SILVER BROMIDE AND ON PHOTOGRAPHIC PROPERTIES OF NUCLEAR EMULSIONS. A. A. Pankova and K. S. Bogomolov. Translated from Trudy Vsesoyuz. Nauch.-Issledovatel'. Kinofotoinst., 11(21), 49-57(1957). 14p.

The effects of Au, NaSCN, and $Na_2S_2O_3$ sensitizers on the properties of photoemulsions were studied. It was found that thiocyanates cause $AgBr_2$ recrystallization during aging; as SCN^- concentration increases, the degree of recrystallization increases. Studies of photographic properties of the emulsion using various sensitizer concentrations established new optimum concentrations. (T.R.H.)

9563 EFFECT OF SOLUTIONS OF URANIUM SALTS AT VARIOUS pH ON THE SENSITIVITY OF IONOGRAPHIC EMULSIONS. M. Nicolae and V. Labău. Acad. rep. populare Romîne, Inst. fiz. atomică şi Inst. fiz., Studii cercetări fiz., 11: 605-14(1960). (In Romanian)

The effect of concentrated solutions of various uranium salts in the interval from $pUO_2 = 0.097$ [$(UO_2(NO_3)_2 \cdot 6H_2O)$ 20%] to $pUO_2 = 3.75$ [$(5.4\ UO_2(NO_3)_2 \cdot 6H_2O)\ 10^{-4}$%] on ionographic emulsions was studied in the case where the pH of the solutions was previously reduced to a value in the interval pH 6 to 7. This study presents a practical interest since, in order to study the processes of uranium fission and of some of its nuclear reactions by means of the photographic method, it is necessary to introduce in the photographic emulsion a quantity of uranium salt. The work also has a theoretical interest dealing with the problem of the influence of strange ions introduced in large quantities in the emulsion on the efficiency of the formation of the latent image. In the method employed, the effect of the concentration of the UO_2 ions on the intensity of the development was avoided by prolonged washing of the plate in cold water before the development operation. It was shown that the solution of uranyl nitrate neutralized (pH 6.2) with a concentration of uranyl ions less than 0.2 N (5% $UO_2(NO_3)_2 \cdot 6H_2O$) does not affect in a significant fashion the sensitivity of ionographic emulsions. The solutions of uranyl nitrate neutralized with a concentration of uranyl ions higher than 0.2 N desensitizes the emulsions. The effect of desensitization is partially reversible, which is easily explainable by supposing that the effect is caused by the effect of the double electric layer of the ions of the solution, adsorbed on the crystal surface or in the diffuse layer. (tr-auth)

9564 PARTICLE IMPACTION EFFICIENCIES FOR BODIES IN A FREE MOLECULE FLOW. S. K. Friedlander (Johns Hopkins Univ., Baltimore). ARS Journal, 31: 96, 153-4(Jan. 1961).

To study fall-out at great altitudes, particle impaction on an exposed surface of a sampling rocket has been proposed. Calculations of impaction efficiency are shown for the case above 60-miles altitude where the particle mean free path exceeds 1 in.; at this altitude a problem in free molecule flow is created. In considering the flux on an elemental area in a free molecule flow, equations are derived which make it possible to calculate the efficiency of impaction of suspended particles on a body moving through the gas. The impaction efficiency, defined as in continuum flow, is the fraction of the particles swept out by the body. Expressions are derived for a flat ribbon set at an angle to the flow, the sphere and the cylinder placed normal to the flow. As an example of the application of the results, the impaction of molecule clusters 10A in diameter on a spherical body traveling at an altitude of 75 miles may be considered. The impaction efficiency at 269 fps is 2.45; at 538 fps, 1.47; and at 807 fps, 1.20. (T.R.H.)

9565 ADVANCES IN ELECTROSTATIC PROPULSION. A. T. Forrester and J. M. Teem (Electro-Optical Systems, Inc., Pasadena, Calif.). Astronautics, 6: 34-7; 86-90 (Jan. 1961).

A discussion of the first ARS Specialist Conference in Electrostatic Propulsion, held at the U. S. Naval Postgraduate School, Monterey, California, on November 3 and 4, 1960, is given. Cesium ion motor technology, various types of gas-discharge ion sources, instruments for the diagnosis of ion motor operation, and the problem of neutralization in space were among the topics discussed. Summaries of several of the papers presented at the conference are included. (M.C.G.)

9566 THERMOELECTRIC GENERATION. J. Shields (Research Lab., AEI Ltd., Rugby, Eng.). Brit. Power Eng., 2: No. 2, 26-30; 34(Jan. 1961).

The reasons for the choice of semiconductors as materials for thermocouple generators are given, and the potentialities of this means of generation are illustrated with reference to the general properties of semiconductors. The electrical efficiency of thermoelements is related to the figure of merit of various materials at 400 to 1000°K. Semiconductors offer the highest efficiencies. Preparation and measurement techniques are outlined, and lead telluride is taken as an example. Progress in the field depends on progress in preparing materials with a high figure of merit and constructing thermocouples with good heat transfer properties. (T.R.H.)

9567 A NOTE ON THE SOLUTION OF THE FOKKER-PLANCK EQUATION FOR THE HARMONIC OSCILLATOR. Joseph Higgins (Univ. Libre, Brussels). Bull. classe sci., Acad. roy. Belg., 46: 385-9(1960). (In English)

The basic solution of the Fokker-Planck equation for an harmonic oscillator, obtained by Prigogine and Philippot (Physica, 23: 569(1957)), was studied by a simpler method than that used in the original work. (tr-auth)

9568 THE INFLUENCE OF SOME VOLATILE ELEMENTS ON THE INTENSITIES OF SPECTRAL LINES OF Sm, Eu, Gd AND Dy IN THE DC ARC. Sima Held (Israel Atomic Energy Commission, [Tel Aviv]). Bull. Research Council Israel, Sect. A, 9: 173-6(Nov. 1960). (In English)

An extremely strong temperature dependence of the intensity ratio of atom and ion lines of europium was observed. The shape of the lines of samarium, europium, gadolinium, and dysprosium changes in the presence of elements with different ionization potentials. Using Li_2CO_3 as a "carrier," a satisfactory sensitivity for samarium, europium, gadolinium, and dysprosium in graphite powder may be obtained in the d-c arc. (auth)

9569 A POLARIZED NEUTRON BEAM PRODUCED BY BRAGG REFLECTION FROM CO–FE ALLOY. M. A. Clark and J. M. Robson (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Can. J. Phys., 39: 1-12(Jan. 1961). (AECL-1134)

A single crystal of Co–Fe alloy was used to produce a diffracted beam of neutrons with a flux of 2.6×10^6 neutrons/cm^2/sec over an area of 1.5 by 1.5 in. This beam contains 92 ± 5% first-order neutrons ($\lambda = 1.37$ Å, $E = 0.0436$ ev), 3 ± 5% second- and higher-order neutrons, and 5% incoherently scattered neutrons. The first-order part of the beam has a polarization of 0.98 ± 0.01; the second-order part of the beam has a polarization of 0.36 ± 0.03 in the same direction as the first-order part, and the over-all beam has a polarization of 0.92 ± 0.05. The neutron

spins can be reversed by the magnetic resonance technique with flipping efficiencies of 98% for the first order and 97% for the over-all beam. (auth)

9570 EXPRESSION OF THERMODYNAMIC QUANTITIES IN TERMS OF A QUASI-PARTICLE DISTRIBUTION FUNCTION. Roger Balian and Cyrano de Dominicis. Compt. rend., 250: 4111-13(1960). (CEA-1736). (In French)

A method is given for calculating thermodynamic quantities with a given density for an anisotropic system. The particular case of zero temperature is given. (auth)

9571 MEASUREMENT OF THE SPEED OF SOUND IN WATER AS A FUNCTION OF TEMPERATURE UP TO 300°C, AND OF PRESSURE UP TO 150 kg/cm^2. Salomon Elberg. Compt. rend., 251: 654-6(Aug. 1, 1960). (CEA-1714). (In French)

In order to localize the boiling front in a water reactor under pressure or a "loop" outside the pile simulating its thermal behavior, the speed of sound in water up to a temperature of 300°C and a pressure of 150 kg/cm^2 was measured using the method of ultrasonic echos. (auth)

9572 CALCULATION OF THE ELECTRIC CONDUCTIVITY AND THE TEMPERATURE OF A WEAKLY IONIZED GAS. Jacqueline Naze. Compt. rend., 251: 2464-6 (Nov. 28, 1960). (In French)

By applying the properties shown in a preceding article (Compt. rend., 251: 854 (1960)) of the linear collision operator K for a $1/r^5$ law, the temperature and the electric conductivity of ions and electrons are calculated. The electric field is not necessarily weak. (tr-auth)

9573 STUDY OF THE REACTIONS PRODUCED BY MOLECULAR HYDROGEN IONS CROSSING THROUGH A GAS. Joseph Guidini, René Belna, Georges Briffod, and Claude Manus (Centre d'Etudes Nucléaires, Saclay, France). Compt. rend., 251: 2496-8 (Nov. 28, 1960). (In French)

The cross section for the production of neutral and charged particles by the passage of H_2 ions at 45 kev through hydrogen was studied. The scattering of the secondary particles was also determined. (tr-auth)

9574 COOLING BY ADIABATIC DEMAGNETIZATION OF NUCLEAR SPINS. N. Kurti (Clarendon Lab., Oxford). Cryogenics, 1: 2-11(Sept. 1960).

The theoretical basis is laid for cooling by isentropic reduction of magnetic fields in paramagnetic salts. The requirements for successful nuclear cooling are discussed. A new nuclear cooling apparatus was used to show that during the warming-up step the conduction electrons are in thermal contact with the electronic stage. The temperature dependence of the relaxation time and interaction energy was determined. The effects of heat contact during demagnetization on the final temperature was studied. Work in this field is reviewed. (D.L.C.)

9575 THE ELECTRICAL RESISTIVITY OF PLUTONIUM, NEPTUNIUM, AND SOME PLUTONIUM ALLOYS. J. A. Lee (Atomic Energy Research Establishment, Harwell, Berks, Eng.), G. T. Meaden, and K. Mendelssohn. Cryogenics, 1: 52-3(Sept. 1960).

Data are reported for the electric resistivity of plutonium, neptunium, and three δ-stabilized aluminum–plutonium alloys at 1.5 to 300°K. Two plutonium samples in the α phase were used which had the densities 19.625 and 19.195 g/cm^3; the data fitted to the equation $\rho = \rho_0 + BT^n$ gave ρ_0 = 13.9 and 32.6% of the ice-point values and n = 2.3 below 33°K and 2.0 below 26°K, respectively. The δ-stabilized aluminum–plutonium alloys contained 10, 5, and 3 at.% aluminum; their ρ vs. T curves are similar to those for plutonium. For α-neptunium, n was found to be 3.1 below 31°K, and ρ_0 is 3.55 μΩ cm (2.7% of ice-point value), very low compared with the plutonium samples. The results are discussed in terms of plutonium being ferromagnetic. (D.L.C.)

9576 RADIOTHERMOLUMINESCENCE OF ORGANIC COMPOUNDS. V. G. Nikol'skii and N. Ya. Buben (Inst. of Physical Chemistry, the Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 134: 134-6(Sept. 1, 1960). (In Russian)

Samples of polyethylene, paraffin, polyisobutylene, teflon, natural and synthetic rubber, and cyclohexane were irradiated with 1.5-Mev electrons at 100°K to an integral dose of 10^6 rad. The irradiated samples were stored in liquid nitrogen, and on warming at 15 degrees per minute, emission of luminescence could be observed with a maximum in intensity at a definite temperature. Thus an intensity maximum was found at −120°C for high- and low-pressure polyethylene. The high-pressure polyethylene sample showed another emission peak at −40°C that was not observed in the low-pressure polyethylene sample. The thermoluminescent emission maxima are associated with the freezing of molecular motion and structural changes in the molecule that can be detected by changes in dielectric properties, heat capacity, specific volume, etc. There is a close correspondence of the maxima in thermoluminescence with structural transitions in these compounds that can be detected by other methods (nuclear resonance, variation of Young's modulus with temperature, etc). Hence radiothermoluminescence can be a very sensitive method of investigating structural changes in a substance. (TTT)

9577 STUDY OF THE DYNAMICS OF SOLIDS AND LIQUIDS BY MEANS OF SLOW NEUTRON SPECTROMETRY. G. P. Felcher and M. Musci (Laboratori CISE, Milan and Istituto di Fisica del Politecnico, Milan). Energia nucleare (Milan), 7: 772-92(Nov. 1960). (In Italian)

The inelastic scattering of slow neutrons by solids and liquids is considered. A brief outline is given of the basic concepts of the theory of neutron-phonon interaction, and the most significant experiments on this subject are reviewed. (auth)

9578 STEREOAUTORADIOGRAPHY. Lars-G. Erwall and T. Westermark (Royal Inst. of Tech., Stockholm). Intern. J. Appl. Radiation and Isotopes, 9: 119-20(Dec. 1960). (In English)

The possibility of using a stereo pinhole camera for studies of the spatial distribution of a radioactive material was investigated. A three-pinhole camera was used to photograph three neutron-irradiated tungsten wires placed on a staircase with 10 mm distance between the planes. Calculation of the distances gave good results. The relevant equations are given for the case of a two-pinhole camera. (D.L.C.)

9579 THE STRUCTURE OF A SHOCK WAVE IN AIR TAKING ACCOUNT OF THE KINETICS OF CHEMICAL REACTIONS. N. M. Kuznetsov. Inzhener.-Fiz. Zhur., Akad. Nauk Belorus, S.S.R., 3: 17-24(Sept. 1960). (In Russian)

Within the limits of accuracy of chemical reaction rate constants known at the present time, the problem of the distribution of temperature and concentrations of components of dissociating air in the nonequilibrium region beyond the steep leading edge of a shock wave in rarefied air can be considerably simplified and can be solved completely without cumbersome calculations. The temperature in the nonequilibrium region is determined with sufficient accuracy

only by the concentration of molecules of oxygen and nitrogen. The time for equilibrium to be reached is determined by the rate of dissociation of oxygen at low initial temperatures, by the rate of dissociation of nitrogen oxide, and by the rate of the reaction $NO + O \rightarrow N + O_2$ at high initial temperatures. Dissociation of nitrogen for values of reaction rate constants assumed in the paper takes place by a chain mechanism with the formation of nitrogen oxide as an intermediate link. The distribution of concentrations of nitrogen oxide beyond the wavefront can be obtained after determination of the temperature profile. The dependence of wave structure on two initial parameters, velocity and density of gas in front of the wave, can be represented graphically in the form of a single-parameter family of curves. (auth)

9580 EXPERIMENTAL INVESTIGATIONS OF THE CESIUM PLASMA CELL. W. A. Ranken, G. M. Grover, and E. W. Salmi (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys., 31: 2140-53(Dec. 1960).

Some aspects of the performance of a cesium plasma cell with tantalum emitter are evaluated in terms of experimental determinations of the effects of variations in such parameters as cesium vapor pressure, emitter temperature, and emitter-collector separation distance. Experiments relating to the effect of collector serrations and to the feasibility of radiation shielding are described. Voltage-current characteristics are presented for several emitter temperatures and for a wide range of cesium vapor pressure. (auth)

9581 ELECTRON MICROSCOPE OBSERVATIONS OF FISSION FRAGMENT TRACKS IN THIN FILMS OF UO_2. T. S. Noggle and J. O. Stiegler (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 31: 2199-2208(Dec. 1960).

Electron microscope studies of the tracks produced by fission fragments in thin films of UO_2 established a 100% detection efficiency for fission events in films 100 A or less in thickness. A background texture decreases the efficiency in thicker films. The tracks register in the films primarily as a result of a redistribution of surface material arising from the disturbance produced by the continuous loss of energy of the fragment by electron excitation and ionization. The minimum rate of energy loss which registers as a track in the film is on the order of 1000 ev/A. Track length distributions, however, suggest that as yet unrecognized free surface effects may also contribute to the track registration. (auth)

9582 ATOM EJECTION PATTERNS IN SINGLE-CRYSTAL SPUTTERING. G. S. Anderson and G. K. Wehner (General Mills, Inc., Minneapolis, Minn.). J. Appl. Phys., 31: 2305-13(Dec. 1960).

Experimental studies of the atom ejection patterns in single-crystal sputtering mostly by Hg^+ ions were made. These patterns give evidence of the anisotropic spread of energy from a collision center, and support the concept of focusing collisions in nearest and next-nearest neighbor directions. In germanium the patterns were found to be strikingly similar to those from a bcc crystal. This could be explained by assuming that under ion bombardment so many interstitials are formed near the surface that the atom arrangement of the germanium crystal resembles that of a bcc lattice. (auth)

9583 STUDIES IN MOLECULAR DYNAMICS. II. BEHAVIOR OF A SMALL NUMBER OF ELASTIC SPHERES. B. J. Alder and T. E. Wainwright (Univ. of California, Livermore). J. Chem. Phys., 33: 1439-51(Nov. 1960). (UCRL-6080-T)

The equation of state and the collision rate for systems ranging in size from 4 to 500 particles are described. The dependence of the results on the number of particles is qualitatively discussed and insight is gained as to what is required of more accurate analytical theories. By comparing the results to various available analytical theories, their region of validity is established. The number of particles necessary at various densities to obtain a quantitative description of the equilibrium properties is delineated. Whether a first-order phase transition exists for hard spheres remains open until larger systems are investigated. (auth)

9584 PHYSICAL PROPERTIES OF ISOTOPICALLY SUBSTITUTED CLASSICAL FLUIDS. W. A. Steele (Pennsylvania State Univ., University Park). J. Chem. Phys., 33: 1619-24 (Dec. 1960).

The observed differences in physical properties between isotopically substituted classical fluids are treated in terms of the theorem of corresponding states. It is shown that these differences are at least partially due to changes in the intermolecular potential energies of interaction. When the potential function of an isotopically substituted molecule is conformal with that of the unsubstituted molecule, the differences in the physical properties of the fluids can be quantitatively related to the differences in the depth and spatial extension of the potential functions and to the changes in the internal degrees of freedom of the molecules. It is shown that the measured properties of perdeutero benzene-benzene and perdeutero cyclohexane-cyclohexane are consistent with these equations, and that the values of the parameters chosen to fit the theory to the data are reasonable. The limits of applicability of this treatment and its possible extension to less simple systems are discussed. (auth)

9585 VARIATIONAL CALCULATION OF MAGNETIC HYPERFINE INTERACTION. NITROGEN ATOM. T. P. Das (Columbia Univ., New York) and A. Mukherjee (Saha Inst. of Nuclear Phys., Calcutta, India). J. Chem. Phys., 33: 1808-13 (Dec. 1960).

A variational method, employing the unrestricted Hartree-Fock approximation, is proposed for the calculation of isotropic magnetic hyperfine constants in paramagnetic atoms and ions with unpaired electrons in non-S states and in free radicals. The method is applied to the ground state of the nitrogen atom. The N^{14} hyperfine constant in the ground state is calculated to be +7.3 Mc as compared to the recent experimental value of +10.4509 ± 0.0003 Mc. Reasons for the discrepancy are discussed. (auth)

9586 DETERMINATION OF RELATIVE ELECTRONIC TRANSITION PROBABILITIES BY IMPACT METHODS. F. H. Dorman and J. D. Morrison (Commonwealth Scientific and Industrial Research Organization, Melbourne). J. Chem. Phys., 34: 578-82(Feb. 1961).

The possibility of obtaining relative electronic transition probabilities from ionization efficiency data is discussed. It is claimed that measurements of relative maximum ionization cross section lack much theoretical significance. It is shown that the factors determining the detailed form of the ionization efficiency curves need to be considered, and that when this is done it should be possible to calculate relative transition probabilities from the experimental data. An illustration is given of such a calculation for several states of excited and ionized krypton and xenon. (auth)

9587 DECOMPOSITION OF CARBON DIOXIDE IN AN ELECTRIC DISCHARGE. M. Faraggi (Commissariat à

l'Energie Atomique, Paris). J. chim. phys., 647-8(1960). (In French). (CEA-1584)

The decomposition of CO_2, both pure and with traces of O_2, NO_2, and CO by a silent electric discharge was studied as a function of the electric power and the time of passage in the discharge at atmospheric pressure and room temperature. The reaction products are CO, O_2, and O_3. The ratio CO/O_3 is practically constant and the radiolytic efficiencies $G_{(CO)}$ vary between 2.7 and 0.5. A mechanism was developed to explain the chemical reactions; the electron-molecule interaction appears to be propagated by a mechanism of successive excitation. (auth)

9588 A NOTE ON THE CAUSE OF SUDDEN IONIZATION ANOMALIES IN REGIONS REMOTE FROM HIGH-ALTITUDE NUCLEAR BURSTS. C. M. Crain and P. Tamarkin (RAND Corp., Santa Monica, Calif.). J. Geophys. Research, 66: 35-9 (Jan. 1961).

Sudden changes of VLF propagation characteristics, caused by the very high altitude Hardtack nuclear detonations in the summer of 1958, occurred on propagation paths thousands of kilometers from the burst point. The anomalies were caused by bomb-induced ionization in the ionospheric D layer, and their onset was much more sudden than those occasioned by natural phenomena such as solar flares. The model discussed provides an explanation of how ionization is suddenly produced in ionospheric regions shadowed from a high-altitude detonation or its conjugate point. (auth)

9589 AN ESTIMATE OF ELECTRON DENSITIES IN THE EXOSPHERE BY MEANS OF NOSE WHISTLERS. Joseph H. Pope (Geophysical Inst., College, Alaska). J. Geophys. Research, 66: 67-75 (Jan. 1961).

The nose whistler dispersion equation was numerically integrated using the following assumed functions for the electron density distribution: $N = K$, $N = KR^{-3}$, and $N = KR^{-3} \exp(3.03/R)$. N is the electron number density, R is the distance from the earth's center, and K a constant of proportionality. Several whistlers that were received on March 19, 1959, were analyzed to obtain electron densities. Each of these whistlers consists of a number of branches having successively lower nose frequencies. Measurements of the nose frequencies and the time of propagation of the nose frequency yield values of the constant K from which the electron density can be determined at any point. It was found that the results for the first two functions disagree systematically with the curve of the assumed function. The third function, suggested by F. S. Johnson on the basis of theoretical considerations, fits the data well within the experimental errors. The resulting distributions cover the range between 4 and 6 earth radii, giving densities varying from 20 to 5 electrons per cm^3. (auth)

9590 MOLECULAR COLLISIONS. II. DIATOMIC MOLECULES. George Gioumousis (Univ. of Wisconsin, Madison and Shell Development Co., Emeryville, Calif.) and C. F. Curtiss. J. Math. Phys., 2: 96-104(Jan.-Feb. 1961).

A set of coupled integral equations describing the collisions of diatomic molecules is developed by exploitation of the properties of the irreducible representations of the three-dimensional rotation group. An expansion of the cross section in spherical harmonics is described, and its virtues argued. (auth)

9591 MEASUREMENT OF THE LUMINESCENCE INDUCED BY THE α RADIATION FROM Po^{210} IN AIR AND IN WATER. M. Duquesne and I. Kaplan (Inst. du Radium, Paris, France). J. phys. radium, 21: 708-16(Oct. 1960). (In French)

A description of the experimental device is given, the main piece of it being a photomultiplier with a quartz window. A method is suggested to determine the number of photons produced, individually, by each α particle in the scintillating substance. The shape of the pulse spectrum connected with the emission of light is explained. The geometry efficiency of light collection is calculated by means of different hypotheses as to the distribution of the photons along the track of the α particles. The sensitivity of this mode of detection is shown by the fact that one is able to observe such a small scintillation as that of water, which has been estimated to 2 to 3 photons per α particle of 2.5 Mev, in the range of wavelengths from 2200 to 5200 Å. In air, the radiochemical yield was evaluated as 6×10^{-4} photon per ion pair, in the same range of wavelengths, and a rough experiment shows evidence that nitrogen is responsible for the luminescence. (auth)

9592 PHOTOGRAPHIC STUDY OF THE FISSION TRACKS OF URANIUM-235 IN IONOGRAPHIC PLATES. R. Pfohl and J. P. Lonchamp (Laboratoire de Physique Corpusculaire, Strasbourg, France). J. phys. radium, 21: 717-27(Oct. 1960). (In French)

Evidence is given of the characteristic thinning down of the "light-ion" track in certain emulsions (G5, L4, and C2). The explanation of this experimental fact is based on the action of δ rays of weak energy and is confirmed by comparison with Ar^{40} ion tracks and by use of low-sensitivity (K0, K-1, and K-2) or diluted emulsions. (auth)

9593 EXPERIMENTAL RANGE-ENERGY RELATIONSHIPS FOR LIGHT IONS WITH LOW ENERGY IN NUCLEAR EMULSIONS. Cao Xuan Chuan (Office de l'Energie Atomique, Saigon, Vietnam). J. phys. radium, 21: 757-9(Oct. 1960). (In French)

A range-energy relationship for the ions B^{11} and C^{13} at several Mev was obtained. For the experimental study (n,α) reactions on O^{16} and N^{14} were used at very high neutron energies. To identify the (n,α) reactions ionization, the α path as a function of angle between α and incident neutron, the energy of the recoil nucleus, and pulse conservation were used as criteria. If these criteria were satisfied, then the path of the residual nucleus was measured. The path-energy curves for B^{11} and C^{13} are shown. That of B^{11} is a little shorter and that of C^{13} a little longer than the curves previously measured and calculated. (J.S.R.)

9594 INCOHERENT SCATTERING BY FREE ELECTRONS AS A TECHNIQUE FOR STUDYING THE IONOSPHERE AND EXOSPHERE: SOME OBSERVATIONS AND THEORETICAL CONSIDERATIONS. Kenneth L. Bowles. J. Research Natl. Bur. Standards, 65D: 1-14(Jan.-Feb. 1961).

Incoherent scattering of radio waves by the free electrons of the ionosphere has been suggested as a technique for measuring the electron density profile both below and above the F region maximum. Observations are reported which confirm the existence of the incoherent scatter and show that its intensity is essentially the predicted value. The observed Doppler broadening is considerably smaller than that originally predicted. An explanation for the reduced Doppler broadening is offered. The scatter is explained as arising from statistical fluctuations of electron density, the distribution of which is controlled by the positive ions. (auth)

9595 ON THE THEORY OF DIFFRACTION BY A COMPOSITE CYLINDER. Ralph D. Kodis (Brown Univ., Providence, R. I.). J. Research Natl. Bur. Standards, 65D: 19-33(Jan.-Feb. 1961).

Formulas are developed for the diffracted field around a perfectly conducting cylinder with a dielectric sleeve of arbitrary thickness. These formulas represent the field due to a unit electric line source parallel to the cylinder (either inside or outside the dielectric sleeve) as a spectrum of radial eigenfunctions. In each case the field in the region containing the source can be expressed as the sum of two terms, the first of which is a spectral representation of the field when the outer as well as the inner surface of the dielectric is a perfectly conducting boundary. The second term of the sum, which alone involves the properties of the dielectric, is an integral that converges rapidly at high frequencies. Using these general results, perturbation calculations are carried out for three limiting examples of plane wave scattering: (1) thin dielectric, (2) low-refractive index, and (3) very small surface curvature. In the latter approximation the correspondence with optical results is shown. (auth)

9596 BASIS OF PARAMAGNETIC NUCLEAR RESONANCE. II. A. Lösche (Karl Marx Univ., Leipzig, Germany). Kerntechnik, 2: 389-91(Dec. 1960). (In German)

The experimental technology of simple scanning methods is described. Application possibilities are indicated. (tr-auth)

9597 EXPERIMENTAL TECHNOLOGY IN NEUTRON DIFFRACTION. Gernot Lutz (Inst. für Kristallographie, Munich, Germany). Kerntechnik, 2: 391-7(Dec. 1960). (In German)

The experimental basis of neutron diffraction, which permits the scattering of monochromatic neutrons on solids and the recording of the intensity and position of the spectra originated, is described. By using the neutron diffraction spectrometers placed in the Garching Research Reactor as a special example, detailed engineering data and construction procedure of the spectrometer and of the electronic measurement apparatus and automatic recording devices are given. (tr-auth)

9598 ELECTROCHEMICAL INVESTIGATION OF THE TRANSITION FROM TETRAGONAL TO CUBIC CAESIUM PLUMBO CHLORIDE. Chr. Kn. Møller. Kgl. Danske Videnskab. Selskab, Mat.-fys. Medd., 32: No. 15, 1-21(1960). (In English)

The cesium halide concentrations for which Cs_4PbX_6 and $CsPbX_3$ (X = Cl or Br) together may be in equilibrium with aqueous solutions of CsX were determined as a function of the temperature. The range of stability for $CsPbX_3$ alone in equilibrium with such solutions at room temperature was obtained. Measurements at a series of temperatures of the e.m.f. of electrochemical cells, where crystalline $CsPbCl_3$ was involved in the electrode processes allowed a determination of the entropy change, ΔS, for the process $CsPbCl_3$ (tetragonal) $\rightarrow$ $CsPbCl_3$ (cubic). The value thus obtained is $\Delta S = 4.0$ cal/mol. degree. On the assumption that the process is essentially an order-disorder transformation, an elementary calculation based on Boltzmann's relation gives $\Delta S = 4.1$ cal/mol. degree. The results are compared with those for $BaTiO_3$. (auth)

9599 RADIATIVE RECOMBINATION OF He. A. Burgess and M. J. Seaton (University Coll., London). Monthly Notices Roy. Astron. Soc., 121: 471-3(1960).

Recombination coefficients for $He^+ + e \rightarrow He(n^{2S+1} L) + h\nu$ are tabulated for $T = 0$, 1×10^4 and 2×10^4. Hydrogenic data are used for $L \geq 2$, but allowance is made for the nonhydrogenic character of the He nS and nP states. (auth)

9600 INTENSITY OF UNSCATTERED GAMMA RAYS INSIDE CYLINDRICAL SELF-ABSORBING SOURCES. D. F. Rhodes, R. A. Stallwood, and W. E. Mott (Gulf Research and Development Co., Pittsburgh). Nuclear Sci. and Eng., 9: 41-6(Jan. 1961).

A general expression for the intensity of unscattered γ rays at points on the axis of a cylindrical absorber, surrounded by a ring-shaped self-absorbing source of rectangular cross section, was derived in terms of two integrals that were evaluated on the IBM 704 computer. The results are presented in the form of curves from which the intensity can be determined for a wide variety of cases. For points not on the axis of symmetry a solution is given for the special case of source with large peripheral dimensions. (auth)

9601 ON THE THEORY OF CLASSICAL FLUIDS. L. Verlet (Laboratoire de Physique Théorique et Hautes Energies, Faculté des Sciences, Orsay, France). Nuovo cimento (10), 18: 77-101 (Oct. 1, 1960). (In English)

It is shown that the summation of a large class of diagrams in a development of the "cluster" type allows establishment of an integral equation for the correlation function in classical fluids. According to one approximation, this equation reduces to that of Born, Green, and Kirkwood, and it reproduces more exactly than that of the virial coefficients. The more and more complicated corrective terms which render the equation exact are given. The three-body correlation function is calculated which, introduced in the equation of Yvon-Born-Green, allows calculation of the two-body correlation function. Thus the direct calculation of this function is confirmed, and it is shown that the integral equation includes corrections for the superposition approximation. (T.R.H.)

9602 INVESTIGATION OF THE INTENSIFICATION OF THE ELECTRON SENSITIVITY OF NUCLEAR EMULSIONS. J. Benes and J. Kubal (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Prague). Phot. Korr., 96: 131-7(1960). (In German)

The sensitivity of nuclear emulsions to electron radiation is increased by triethanolamine and organic compounds which have the radical $(CH_3)_2N-C_6H_4-CH = CH-$. The so-called optical sensitizers have no effect. The sensitization effect of 2-p-dimethylaminostyrylbenzthiazol (2-p-D) depends on the concentration of material used, on the dispersity of the silver halide crystals, on the AgI content in the silver halide crystals, and on the p Br^- value of the emulsion. It is not affected by the Cd^{2+} content in the AgBr in using AgBr emulsions or by the chemical maturation time. The photographic characteristics of nuclear emulsions sensitized by 2-p-D change with time. The sensitivity of the sensitized emulsion layers decreases during the time between production and exposure, whereas the sensitivity of unsensitized emulsions does not. Nuclear emulsions sensitized by 2-p-D record not only the tracks of strongly ionizing particles but also electron tracks from C^{14}. The experimentally obtained dependence of sensitization of nuclear emulsions on the use of 2-p-D is explained. (tr-auth)

9603 ELECTRONS AS A SHOCK DRIVER GAS. R. G. Fowler, G. W. Paxton, and H. G. Hughes (Univ. of Oklahoma, Norman). Phys. Fluids, 4: 234-7(Feb. 1961).

The electric shock tube, below a transition pressure characteristic of the tube diameter and the gas under study, exhibits two clearly distinguishable luminous fronts having the apparent attributes of shocks. The first front is initiated too quickly to be ascribed to a temperature increase of the gas molecules, and therefore seems to depend directly on the electrons and their fields in some way. It is

hypothesized that electron pressure is the primary source of this motion. This hypothesis is consonant with the extensive evidence at hand. (auth)

9604 MEASUREMENT OF THE STRUCTURE OF STRONG SHOCKS IN HELIUM-FILLED T TUBES. Wolfgang Wiese, H. F. Berg, and H. R. Griem (Univ. of Maryland, College Park). Phys. Fluids, 4: 250-3(Feb. 1961).

The structure of Mach 25 shock waves was investigated spectroscopically. Rise times of 0.20 and 0.15 μsec were observed for the HeI 5876 A and the HeII 4686 A lines, respectively, which are consistent with the expected relaxation times, if the hypothesis that the ambient gas is substantially preexcited by ultraviolet radiation from the discharge is adopted. This confirmed earlier conclusions from the measured equilibrium conditions ($T \approx 3$ ev, $N_e \approx 2 \times 10^{17}$ cm^{-3}) and suggested that local thermal equilibrium exists in the region behind the shock. (auth)

9605 SPUTTERING OF SILICON WITH A^{+2} IONS. S. P. Wolsky and E. J. Zdanuk (Raytheon Co., Waltham, Mass.). Phys. Rev., 121: 374-5(Jan. 15, 1961).

A gravimetric technique involving a sensitive quartz microbalance was used for the determination of sputtering yields for the argon ion-bombardment of silicon. The sputtering yield for Ar^{+2} ions was deduced from the results of experiments in which the relative concentrations of Ar^{+} and Ar^{+2} ions were varied in a known manner. On the assumption that sputtering is a kinetic-energy-controlled phenomenon, it was expected that $S_E(Ar^{+2}) = S_{2E}(Ar^{+})$, where S is the number of atoms sputtered by an impinging ion of energy E. This investigation showed, however, that $S_E(Ar^{+2}) \simeq 4S_{2E}(Ar^{+})$. This indicates the influence in the sputtering process of some other factor in addition to the ion kinetic energy. (auth)

9606 MAGNETIC PROPERTIES OF $KMnF_3$. I. CRYSTALLOGRAPHIC STUDIES. Olof Beckman (Univ. of California, Berkeley) and Kerro Knox. Phys. Rev., 121: 376-80(Jan. 15, 1961).

The lattice parameters for $KMnF_3$ were determined by means of an x-ray rotation camera designed for temperatures down to 15°K. The cubic room temperature perovskite structure transformed at 184°K to an orthorhombic phase with D_{2h}^{16} – Pbnm as the most probable space group with a unit cell containing 4 formula units. It had a tetragonal pseudocell with $c/a > 1$ in which the fluorine octahedra about the manganese remained essentially regular but tilted relative to the crystal axes. At 84°K, just below the Néel temperature of 88°K, the pure antiferromagnetic also had a tetragonal pseudocell, but with $c/a < 1$ and the still essentially regular octahedra rotated as well as twisted. Below a second magnetic transition at 81.5°K, the 65°K structure showed in addition, a significant distortion of the regularity of the octahedra. (auth)

9607 EXCHANGE INTERACTION BETWEEN CONDUCTION ELECTRONS AND MAGNETIC SHELL ELECTRONS IN RARE-EARTH METALS. S. H. Liu (Ames Lab., Ames, Iowa). Phys. Rev., 121: 451-5(Jan. 15, 1961). (IS-180).

The interaction Hamiltonian for the Coulomb exchange effect between conduction electrons and magnetic-shell electrons in rare-earth metals was derived from first principles. The approximations under which the interaction can be represented by the product of electron and ion spin vectors are exhibited. (auth)

9608 FORMATION OF F CENTERS IN KCl BY X RAYS. P. V. Mitchell, D. A. Wiegand, and R. Smoluchowski (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 121: 484-98(Jan. 15, 1961).

Measurements were made of the growth of the F band in undeformed, deformed, and heat-treated KCl crystals at room temperature using 140-kvp x-ray irradiation. The growth curves were analyzed in terms of the initial concentration of negative-ion vacancies in the lattice before irradiation, rate of formation of new vacancies, rate of electron capture by the initial and by the new vacancies, and bleaching constants. These parameters were studied as a function of the intensity of irradiation. It appeared that the new vacancies are generated at a rate proportional to the square of the intensity of irradiation and inversely proportional to the dislocation density. Deformation increased the concentration of initial vacancies near dislocations, whereas heat treatment increased the concentration of initial vacancies dispersed in the volume of the crystal. Since neither the jog mechanism nor the Varley mechanism can account for the observations, a new model is proposed which accounts for all the observed phenomena. (auth)

9609 STARK BROADENING OF SPECTRAL LINES BY HIGH-VELOCITY CHARGED PARTICLES. M. Lewis (Yale Univ., New Haven). Phys. Rev., 121: 501-5(Jan. 15, 1961).

The broadening of the Lyman α line by high-velocity charged particles was calculated in the classical path approximation without the completed-collision assumption. For noninteracting perturbers, the divergence at large impact parameters associated with usual impact theories did not arise. Interactions between the perturbers were introduced by the pair correlation function. The resulting line shape was valid for frequencies larger than those permitted by the impact theory. (auth)

9610 INTERFERENCE EFFECTS IN THE RESONANCE FLUORESCENCE OF "CROSSED" EXCITED ATOMIC STATES. P. A. Franken (Univ. of Michigan, Ann Arbor). Phys. Rev., 121: 508-12(Jan. 15, 1961).

The recent spectroscopic method developed by Colegrove, Franken, Lewis, and Sands exploits interference effects that occur in the resonance fluorescence of atoms exhibiting pairs of "crossed" excited states. Some of the theoretical features of the technique are discussed in terms of the formalism developed by Breit from which the salient features of the observed lineshapes can be readily deduced. Alternative derivations of the Breit formula are given together with a discussion of the nature and representation of the requisite resonance radiation. (auth)

9611 CONTINUOUS ABSORPTION DUE TO FREE-FREE TRANSITIONS IN HYDROGEN. Takashi Ohmura and Haruko Ohmura (National Research Council, Ottawa). Phys. Rev., 121: 513-17(Jan. 15, 1961).

The absorption of radiation in the free-free transition of the negative hydrogen ion is the inverse process of bremsstrahlung from an electron in the vicinity of a neutral hydrogen atom. This process is the most important cause of continuous absorption by the atmosphere of the sun and stars in the infrared region. The transition matrix element is expressed, with sufficient accuracy, in terms of the s phase shifts of electron-hydrogen atom scattering alone. To meet the requirement in astrophysical studies, the continuous absorption coefficients due to the free-free transition were tabulated for a wide range of wavelengths (4050 A to infinity) and temperatures (2520 to 10,080°K) of the hydrogen gas, by using the s phase shifts of e–H scattering which include exchange and correlation effects between two electrons. The tabulated coefficients are 2% to 70% less

than the ones computed by Chandrasekhar and Breen, who used Hartree functions without exchange. Further improvement of the present result is discussed. (auth)

9612 NEUTRON DIFFRACTION STUDY OF KRYPTON IN THE LIQUID STATE. Glen T. Clayton and LeRoy Heaton (Argonne National Lab., Ill.). Phys. Rev., 121: 649-53 (Feb. 1, 1961).

The angular distribution of 1.05-A neutrons scattered by krypton in the liquid state at temperatures of 117, 133, 153, 183, and 210°K is reported. By use of a sample cell fabricated from a single aluminum crystal, it was possible to obtain diffraction patterns up to the critical temperature and pressure. The scattering curves were Fourier transformed to obtain the radial atomic distribution function at each temperature. The number of nearest neighbors calculated from these distribution functions ranged from 8.5 at 117°K to 4.0 at 210°K at distances ranging from 4.02 to 4.20 A, respectively. A comparison of radial distribution functions from arbitrarily terminated data showed that the ratio of the last zero-atomic-density position to the first atomic-density-maximum position is a function of the amount of intensity data transformed. It also indicated that the width of the bowl of the effective potential in liquid krypton is in approximate quantitative agreement with that of the Lennard-Jones 12:6 potential. (auth)

9613 SELF-DIFFUSION IN LIQUID He^3. Daniel Hone (Univ. of Illinois, Urbana). Phys. Rev., 121: 669-73(Feb. 1, 1961).

The Landau model of a Fermi liquid was employed to obtain an expression for the coefficient of self-diffusion, D, in liquid He^3. It was found that $D = A/T^2$, where $A \approx 2 \times 10^{-4}$ $cm^2 sec^{-1}$ $degree^2$, and T is the temperature in degrees Kelvin. As this temperature dependence differed from that experimentally observed ($T^{-3/2}$), although the order of magnitude of the theoretical prediction agreed well with experiment, the possible effect of the 1% He^4 impurity known to be present was investigated; it was found that the diffusion coefficient is essentially unaffected by the impurity (a result also obtained experimentally). It was estimated that the Landau model is applicable only well below 0.05°K. As even the most recent experiments were carried out only down to 0.03°K, it was concluded that the transport properties of He^3 should be investigated experimentally at lower temperatures in order to check the validity of the theory. (auth)

9614 INTERPLANETARY MAGNETIC FIELD AND THE AURORAL ZONES. J. W. Dungey (Pennsylvania State Univ., University Park). Phys. Rev. Letters, 6: 47-8(Jan. 15, 1961).

A qualitative model of the interplanetary magnetic field is outlined. A steady laminar flow of interplanetary plasma moving relative to the earth was assumed. Hoyle's suggestion that the primary auroral particles are accelerated at neutral points in the combination of an interplanetary field and the geomagnetic field was investigated. The model was confirmed by agreement with the observed S_D current system. (M.C.G.)

9615 ASPHERICAL 3d ELECTRON DISTRIBUTION IN Ni. Harvey A. Alperin (Naval Ordnance Lab., White Oak, Md. and Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 6: 55-7(Jan. 15, 1961).

Measurements were made of the aspherical form factor of an antiferromagnetic single crystal of nickel oxide using unpolarized neutrons. The form factor of Ni^{2+} was found to lie above the free-atom curve. Integrated intensities of all nuclear and magnetic reflections were measured up to a value of $\sin\theta/\lambda = 0.78$ using a wavelength of 1.046 A. To investigate the possibility that the observed results might be due to the effect of anisotropic motions, the reflections that occurred at the same Bragg angle were measured after cooling the crystal from 297 to 117°K. The aspherical unpaired 3d electron distribution observed experimentally was just what was expected due to the splitting of energy levels of the d electrons in the field of the anions. (M.C.G.)

9616 ELECTRIC QUADRUPOLE SPLITTING AND THE NUCLEAR VOLUME EFFECT IN THE IONS OF Fe^{57}. S. DeBenedetti, G. Lang, and R. Ingalls (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev. Letters, 6: 60-2(Jan. 15, 1961).

A study of the Mössbauer spectra of Fe^{57} in chemical compounds revealed some regularities. Typical transmission curves for Fe^{2+} and Fe^{3+} compounds relative to an unsplit room-temperature stainless-steel source are shown. Both patterns exhibited a shift of the center of gravity from the zero velocity. The Fe^{2+} curve showed the two absorption lines characteristic of a pure nuclear electric quadrupole interaction. Data on quadrupole splittings and chemical shifts are given. (M.C.G.)

9617 PHOTON ROCKET. G. G. Zel'kin. Priroda, 49: No. 11, 69-72(Nov. 1960). (In Russian)

The following list of the efficiency coefficients of potential rocket-fuel types indicates the relative yields of mass transformed into energy: chemical—$5 \cdot 10^{-11}$, plasma—$5 \cdot 10^{-10}$, ionic—$5 \cdot 10^{-8}$, nuclear fission—$1 \cdot 10^{-3}$, nuclear fusion—$4 \cdot 10^{-2}$, and photon (ideal case)—1. These figures are based on the assumption that the usable energy is transformed into kinetic energy without losses under adiabatic conditions. A photon rocket, weighing 50 tons (without fuel) and designed to travel for 1 year, must be accelerated to a velocity of 0.886 c requiring a total weight of 200 tons. Transformation of 150 tons of mass into photons corresponds to an energy generation of $3.76 \cdot 10^{15}$ kw-hr, compared to a total electric energy production on the earth of only $3 \cdot 10^{12}$ kw-hr in 1957. Among the many theoretical and practical problems discussed are problems relating to efficient transformation mechanisms, annihilation processes in the photon engine, hot plasma temperatures, and heat insulation. (TTT)

9618 ON THE BOUND STATES OF A GIVEN POTENTIAL. Julian Schwinger (Harvard Univ., Cambridge, Mass.). Proc. Natl. Acad. Sci. U. S., 47: 122-9(Jan. 1961).

It is a fundamental property of any spherically symmetrical potential V(r) for which $\int_0^\infty dr\, r|V(r)|$ exists that there are only a finite number of bound states. This has been expressed by V. Bargmann in the form of the inequality $(2l+1)n_l < \int_0^\infty dr\, |V(r)|$, where n_l is the number of bound states for given l (and magnetic quantum number m_l). The method of derivation of the latter result is sufficiently specialized, however, that it is not easily applied to nonspherically symmetrical potentials, for example, or to the tensor forces that appear in the two-nucleon problem. Another derivation of this inequality is presented, together with some of its extensions. (auth)

9619 ATOMIC COLLISION SEQUENCES IN CRYSTALS OF COPPER, SILVER AND GOLD REVEALED BY SPUTTERING IN ENERGETIC ION BEAMS. R. S. Nelson and M. W. Thompson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Roy. Soc., (London) A, 259: 458-79(Jan. 24, 1961).

Specimens of copper, silver, and gold have been bombarded with 0.3-Mev protons and 10-kev ions of argon and xenon. Atoms were ejected from crystal surfaces with

maximum intensity along low-index crystal directions. The effects are interpreted as being due to the arrival at the surface of three types of focused atomic collision sequence. The first travels along <110> directions, momentum being focused by the geometrical properties of a close-packed line of spheres. No mass transfer is thought to occur in this type of sequence and experiment shows its maximum range in gold to be roughly 350A. The second and third types travel along <100> and <111> directions, and are thought to consist of successive collisions in which the projectile atom replaces the target, focusing being due to the rings of atoms which encircle the projectile's path. A theoretical study shows these rings to behave with formal similarity to the converging lens in optics, and an upper energy limit for focusing is derived. It is predicted that the maximum ranges in copper are roughly 35A for <100> sequences and 120A for <111> sequences, the corresponding values in gold being 50 and 300A, respectively. These predictions are shown to be in agreement with experiment. (auth)

9620 ON THE EFFECT OF THE INTERNAL ELECTRIC FIELD IN NONCONDUCTING PARAMAGNETIC SINGLE CRYSTALS ON THE TWO-PARTICLE SPIN-SPIN INTERACTIONS. N. G. Koloskova and U. Kh. Kopvillem (Lenin State Univ., Kazan). Soviet Phys.-Solid State, 2: 1243-52(Jan. 1961).

The coefficients of the spin hamiltonian of dipole-dipole and anisotropic-exchange interactions between ions with anisotropic g factor and effective electron spin $^1/_2$ are used to calculate the second and fourth moments of the distribution curve of the nondiagonal matrix elements of the spin-spin interaction operator. The results are used to investigate the line shape in paramagnetic resonance and in free magnetic induction. The order of magnitude of the spin-spin paramagnetic relaxation time is estimated. Concrete calculations are made for ethyl sulfates and double nitrates of rare-earth ions. (auth)

9621 FIELD AMPLIFICATION IN ZnSCdS(Mn) PHOSPHORS. G. Wendel (Deutsche Akademie der Wissenschaften, Berlin). Z. Naturforsch. 15a, 1010-11 (Nov. 1960). (In German)

Field amplification in ZnSCdS(Mn) phosphors was investigated. In x-ray excitation (60 kv), field factors of 6, in some cases up to 10, were obtained. The factor was independent of the hardness of the x rays. In ultraviolet excitation a field factor of 1.4 was obtained. The dependence of the field factor on the voltage is shown at various frequencies. The curve is independent of the frequency of the imposed alternating voltage. The dependence on the frequency at a fixed voltage is shown. In excitation by 10 to 60 kv electrons, field factors up to 4 occurred. In α excitation the field factor reached almost 3. (J.S.R.)

9622 INVESTIGATION OF THE EQUILIBRIUM CHARGE DISTRIBUTION IN A FAST ION BEAM. V. S. Nikolaev, I. S. Dmitriev, L. N. Fateeva, and Ya. A. Teplova (Inst. of Nuclear Physics, Moscow State Univ., U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 905-14(Oct. 1960). (In Russian)

The equilibrium distribution of charges in an ion beam of light elements (Z = 2 to 18) and in a krypton ion beam after their passage through He, N_2, Ar, Kr, and a celluloid film was measured for velocities v $\sim 2.6 \cdot 10^8$ cm/sec and higher. Some new information was obtained on the dependence of the mean charge $\bar{i}$ and distribution width σ on the velocity charge of their nucleus and on the medium. Significant differences in the magnitude of $\bar{i}$ in various gases were found for all types of ions. Thus for ions with Z > 10 the value of $\bar{i}$ in a celluloid film exceeds that in gases by 1.6 to 2.3 times. Appreciable deviations from a smooth dependence of $\bar{i}$ and σ on Z were detected in the region Z ~10 to 12. (auth)

9623 SHOCK WAVES IN RELATIVISTIC MAGNETOHYDRODYNAMICS. L. M. Kovrizhnykh (Lebedev Inst. of Physics, the Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1042-5(Oct. 1960). (In Russian)

The properties of a shock adiabate were investigated in relativistic magnetohydrodynamics in the case of perpendicular waves. In a number of limiting cases some simple expressions were derived which relate the thermodynamic quantities on both sides of the discontinuity. The possibility of accelerating charged particles by aid of shock waves is briefly considered. It is shown that in the ultrarelativistic case of perpendicular waves such acceleration is impossible. (auth)

9624 DOUBLE CHARGE EXCHANGE OF ALKALI METAL IONS. Ya. M. Fogel, V. F. Kozlov, and G. N. Polyakova (Khar'kov State Univ. and Crimean Observatory of the Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1186-92(Nov. 1960). (In Russian)

New experimental data on double-charge exchange of Li^+, Na^+, and K^+ ions in a number of gases are presented which confirm the possibility of application of Massey's adiabatic condition to explain the shape of the $\sigma_{1-1}(v)$ curves. Some of the $\sigma_{1-1}(v)$ curves obtained permit conclusions to be drawn regarding the behavior of these curves in the region $v < v_{max}$ near the peak. (auth)

9625 PHENOMENOLOGICAL QUANTUM ELECTRODYNAMICS IN THE CASE OF TWO MEDIA. G. M. Garibyan (Inst. of Physics, Academy of Sciences, Armenian SSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1630-6 (Dec. 1960). (In Russian)

A macroscopic quantum electrodynamics of transition phenomena was constructed. The probabilities for the following first-order processes were computed: transition and Cherenkov radiation and electron-positron pair conversion of photons incident on the boundary of the medium. (auth)

9626 THEORY OF THE KAPITZA THERMAL DISCONTINUITY AT THE BOUNDARY BETWEEN LIQUID He^3 AND A SOLID BODY. I. L. Bekarevich and I. M. Khalatnikov (Inst. of Problems in Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1699-1712(Dec. 1960). (In Russian)

The problem of motion of a Fermi fluid due to vibrations of the boundary was treated. The energy transferred to the liquid during thermal vibrations of the solid body and the related heat transfer at various temperatures of the liquid and body were computed by applying the solutions obtained. The thermal resistance derived is proportional to T^{-3}. (auth)

9627 CONTRIBUTION TO THE THEORY OF SUPERCONDUCTING ALLOYS WITH PARAMAGNETIC IMPURITIES. A. A. Abrikosov and L. P. Gor'kov (Inst. of Problems in Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1781-96(Dec. 1960). (In Russian)

It was demonstrated within the framework of superconductivity theory that the transition temperature, T_c, of a superconductor with paramagnetic impurities is lower than that of a pure metal. The dependence of T_c on the impurity concentration was determined. At a certain critical concentration the superconductivity disappeared. The thermodynamic and magnetic properties of superconducting alloys

in a concentration range close to the critical value were studied in detail. It was found that for $T \rightarrow 0$ there is no exponential term in the expression for the heat capacity in this region. The concentration dependence of the energy spectrum gap of such a system was determined. It was found that for a concentration $n' \approx 0.9\, n_{cr}$ the gap disappears and at large concentrations the system has a continuous spectrum. (auth)

9628 WEAK BOND ENERGIES IN QUANTUM FIELD THEORY. L. D. Landau (Inst. of Problems in Physics, Academy of Sciences, USSR). Zhur. Ekspti'. i Teoret. Fiz., 39: 1856-7(Dec. 1960). (In Russian)

An attempt is made to show that in quantum field theory a direct relation can be developed for weakly bound (but strongly interacting) particles. (R.V.J.)

9629 DROP MODEL OF ATOMIC STRUCTURE. A. F. Kapustinskiĭ (Mendeleev Inst. of Chemistry and Technology, Moscow, U.S.S.R.). Zhur. Strukt. Khim., 1: 217-32 (July-Aug. 1960). (In Russian)

An atomic model is described in which the electrons are approximated by drops surrounding a positive point charge. The model describes noble gas ionic sphericity, electrical shells, diagonal similarities in the periodic system, stability, and contraction of radii. It also offers a simple equation for effective ion radii without empirical parameters. (R.V.J.)

9630 THERMOELECTRICITY, INCLUDING THE PROCEEDINGS OF THE CONFERENCE ON THERMOELECTRICITY SPONSORED BY THE NAVAL RESEARCH LABORATORY, SEPTEMBER 1958. Paul H. Egli, ed. New York. John Wiley & Sons, Inc., 1960. 413p.

A compilation of information on thermoelectricity research is presented. Most of the chapters were presented at the NRL conference, but many have since been expanded and others have been added. Reviews are included. The four sections are entitled: Fundamental Concepts in Thermoelectricity, Basic Parameters in Thermoelectricity, Chemical and Physical Properties of Materials at High Temperatures, and Measurement of Material Properties. (T.R.H.)

9631 DEVICE FOR TRANSFORMING THE ENERGY RADIATED BY RADIOACTIVE MATERIAL INTO ELECTRICAL ENERGY. (to Laboratoires d'Electronique et de Physique Appliquées). French Patent 1,193,049. Apr. 27, 1959.

A nuclear battery is described, consisting of a radioactive source, one or more adjacent luminescent bodies (e.g., silver-activated ZnS) which collect the radiation from said source, and one or more photoelectric cells to convert the luminous energy into electrical energy. (NPO)

9632 RADIOACTIVE PILE. (to Universal Winding Co.). French Patent 1,211,189. Oct. 5, 1959.

A nuclear battery is described consisting of an electrically conducting outer shell, constituting the cathode, and an inner bulb of dielectric material (e.g., glass), the interior wall of which is coated with electrically conducting material (e.g., vaporized Ag, $SnSO_4$) and constitutes the anode. The bulb is filled with a radioactive fluid (Kr^{85}, Cl^{36}, Xe^{133}, or Xe^{135}, (organic) C^{14} compounds, S^{35} compounds, e.g., SO_2) while the space between bulb and shell is filled with metal powder or a low-melting alloy. The thickness of the wall of the bulb is such that the primary electrons, emitted by the fluid, are transmitted but secondary electrons are absorbed. (NPO)

Astrophysics and Cosmology

9633 (JPRS-6604) HUNGARIAN SUMMARIZES IGY FINDINGS ON TERRESTRIAL MAGNETISM. Gyorgy Barta. Translated from Fiz. Szemle, 10: 291-8(Oct. 1960). 16p.

A discussion is given of the IGY findings on terrestrial magnetism. Investigations concerning the secular changes of the terrestrial magnetic field are discussed. The changes are shown on isopor maps which have the individual magnetic components plotted separately. The secular variation is considered to be a global process which appears uniformly over the earth's surface. A survey of the earth's magnetic field is proposed for 1960 to 1965 during a period of minimum sun spots. (JPRS)

9634 POWERED TRAJECTORY STUDIES FOR LOW THRUST SPACE VEHICLES. Robert H. Fox (Univ. of California, Livermore). ARS Journal, 31: 28-32(Jan. 1961).

Powered trajectory calculations have been carried out for missions from Earth to Venus, Mars, Jupiter and return. The procedure used was based upon an optimization that minimizes total energy requirements and maximizes payload. Data are presented which relate payload fraction, total mission time, and minimum specific power requirements. It is shown that propulsion plant weight-to-exhaust power ratios of 122 lb/kw and 22 lb/kw are adequate for missions ranging in difficulty from one-way trips to Mars with 10% payload fraction to round trips to Mars with 30% payload, respectively. In both cases the transfer is assumed to be between low altitude satellite orbits about the planets in question. (auth)

9635 DISTRIBUTION OF DENSITY IN A PLANETARY EXOSPHERE. [PART] II. E. J. Öpik and S. F. Singer (Univ. of Maryland, College Park). Phys. Fluids, 4: 221-33 (Feb. 1961).

In an isolated neutral exosphere three components can be distinguished: elliptic-ballistic, hyperbolic-ballistic, and bound-elliptic. The second component forms the escape flux, which cannot be defined simply. The velocity distribution of all components was calculated as a function of altitude in the exosphere. From this, the importance of the bound orbits can be assessed. Even with the bound orbits completely filled, according to detailed balancing, the velocity distribution is non-Maxwellian; hence the barometric formula cannot be applied to determine the distribution of density. The absence of a Maxwellian distribution is shown to exist at all levels above the reference level (base of the exosphere), and the effective kinetic temperature of the gas is shown to decrease with altitude. The "base of the exosphere" forms the dividing level between the barosphere and exosphere; its conventional definition was reexamined, and it is redefined to correspond to the level from which one-half of the escaping molecules may escape without suffering any collisions. Numerical results for all components vs. altitude are given for neutral hydrogen and oxygen, applicable to the terrestrial exosphere. The contribution of bound orbits was estimated and shown to be minor at all levels. Bound orbits may be important for the exospheres of the outer planets. The interplanetary gas may be considered as an extension of the solar atmosphere; however, caution must be exercised in treating it as an exosphere. (auth)

9636 HYPERON STARS. G. S. Saakyan. Priroda, 49: No. 11, 14-21(Nov. 1960). (In Russian)

The properties of elementary particles are employed to

explain cosmic phenomena. Thus, for example, the collision of two worlds, one composed of "matter" and the other of "anti-matter" would lead to the annihilation of mass and the release of tremendous amounts of electromagnetic radiation. The evolution of very dense and superdense stars is explained by assuming a dense core of some elementary particle surrounded by a degenerate gas of an elementary particle. Thus the white dwarfs such as "Sirius B" with a density 10,000 times greater than that of earth are assumed to be composed of a proton core with a degenerate electron gas to maintain electrical neutrality. At higher densities neutron stars can be formed, but this type of star has not been detected as yet. This star consists of three gases: neutron, proton, and electron. Because of its tremendous gravitational field, the neutron star can deflect light toward itself and act as an enormous collecting lens. This property may make it easier to detect this type of star. With a further decrease in the total energy of the system neutrons can be converted to hyperons, and a hyperon star can be formed with a nucleus of hyperons and nucleons, a surface layer of neutrons, and a shell of bare nuclei and electrons. A collision of a hyperon star with other cosmic bodies can release approximately 20% of the rest mass of the star in the form of radiation. This type of cosmic explosion can explain the origin of supernovae. (TTT)

Cosmic Radiation

9637 (CRGP-974) COLLECTED RESULTS FROM THE COSMIC-RAY STATIONS FOR JULY 1959. H. Carmichael and J. F. Stejes (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.). Sept. 28, 1960. 40p.

For publication with the papers of the Helsinki Symposium on the "July 1959 Event and Related Phenomena."

Mechanically plotted graphs on a common percentage scale of the results from 33 neutron monitors and 13 meson telescopes for July 1959, were prepared in the form of transparencies, and were distributed. A second set of transparencies, in which the Forbush decreases were equalized, as between meson and neutron detectors and as regards latitude effect, was prepared. Selected groups of these transparencies are reproduced in superposition to illustrate the July 17 solar injection and in vertical sequence to demonstrate the geographical location and time dependence of the unusual fluctuations that occurred on July 18 and 19. The very rapid fluctuations that took place near and after midnight on July 17-18, are illustrated using 5, 10, or 15-min readings supplied by some 20 stations and are shown to have been simultaneous and confined to a 3000-mile-diameter area in North America. The July 17 solar increase is used to test the various formulations for cut-off magnetic rigidity. A self-consistent result is obtained using the Quenby and Webber formulation. (auth)

9638 (NP-9536) OBSERVATION OF A SOLAR BREMSSTRAHLUNG BURST AT 1926 UT, 11 AUGUST 1960. J. R. Winckler, T. C. May, and A. J. Masley (Minnesota. Univ., Minneapolis. School of Physics). 11p. Contract NASw-56. (CR-32).

A radiation increase from a solar bremsstrahlung burst during a 2+ flare was observed by balloon detectors. The observation was detected simultaneously by identical equipment at Minneapolis, Minn., and Fort Churchill, Manitoba. The instruments were an aluminum ionization chamber filled with argon, an aluminum Geiger counter, and a copper Geiger counter. The response of the aluminum but not the copper detectors indicates a low-energy x-ray event (~30 kev). The burst appeared suddenly at 1926.0 UT, Aug. 11, rose rapidly to a maximum, and returned to half-intensity at 100 seconds. An average energy flux of 5.1×10^6 ev/cm^2/sec at atmospheric depth was indicated. Close correlation of the event with r-f and optical observations is shown. (T.R.H.)

9639 (NP-9809) A SEARCH FOR A MASS 550 PARTICLE. Technical Report No. 8. George Monnig (Washington Univ., St. Louis). Jan. 1961. 182p. Contract NONR-816.

A review is given of the history of the search for the 550 m_e cosmic particle. An experiment is described in which the range, momentum, and Čerenkov light of cosmic rays are measured. An analysis of the results revealed that there was no evidence for the existence of a mass 550 particle; if a mass 550 particle had produced Čerenkov light and stopped in the range hodoscope, it is unlikely that it would have resembled one of the observed events; and, if a mass 550 particle had produced Čerenkov light and stopped in the range hodoscope, it would have been resolved, partially resolved, or not resolved, depending on its range channel. The measurements are tabulated with calculated values and are given in graphical form. (B.O.G.)

9640 (R60SD391) CHARGED PARTICLE RADIATION IN SPACE. T. R. Riethof (General Electric Co. Missile and Space Vehicle Dept., Philadelphia). Aug. 1960. 33p. (AD-242500).

The charged-particle radiation in space is reviewed, with emphasis on the Van Allen radiation belts. The vehicles and techniques used in measuring the charged-particle radiation are considered in conjunction with the results of the measurements. The data are analyzed to obtain an idea of the distribution of charged particles with respect to location in space (latitude and distance from the center of the earth) and with respect to their mass and energy. A summary of some ideas of the origin of the Van Allen belts is included. Cosmic rays and solar flares are discussed, as well as some effects of particle radiation, with emphasis on the influence on space travel and possible protective techniques. (auth)

9641 (JPRS-7304) INVESTIGATION OF COSMIC RAYS AND TERRESTRIAL CORPUSCULAR RADIATION IN ROCKET AND SATELLITE FLIGHTS. S. N. Vernov and A. E. (Ye.) Chudakov. Translated from Uspekhi Fiz. Nauk 70: 585-619 (1960). 86p.

Two spatially separated zones of high-intensity radiation exist about the earth. In the equatorial plane, the outer zone begins at a distance of about 20,000 km from the center of the earth and extends to distances of about 60,000 km. The boundaries of this zone are lines of force of the geomagnetic field. The particles composing the outer zone are electrons. Two groups of electrons are distinguished on the basis of their energies. The first group consists of electrons with energies of several tens of kev. The second group consists of electrons with energies of the order of 10^6 ev. The inner zone begins at an altitude of 600 km in the equatorial plane in the Western Hemisphere and extends to distances of the order of one earth's radius. The boundary of the inner zone is the line of force coming out of the earth at a geomagnetic latitude of 35°. The particles composing the inner zone are protons with energies about 10^8 ev. Between the two zones, in the geomagnetic-latitude range from 40 to 55°, a region is observed in which elevated radiation intensities are virtually absent. Outside the earth's magnetic field, the radiation consists of protons and other nuclei. (W.L.H.)

9642 ON THE DEPENDENCE OF THE PHOTON-ELECTRON RATIO ON THE DISTANCE FROM THE AXIS OF EXTENSIVE AIR SHOWERS OF COSMIC RADIATION. A. Oleś (Academy of Mining and Metallurgy, Cracow, Poland). Acta Phys. Polon. 19, 461-5(1960). (In English)

The transition curves were determined for two distances of the measuring tray from the detector of extensive air showers. The ratio of the number of photons to the number of electrons was found to increase as the mean distance from the axis of the showers recorded was augmented (from 20 to 100 m). For the range of distances applied, a ~50% variation of the ratio resulted. The sign of the effect observed is in agreement with that predicted by theory of electron-photon cascade. (auth)

9643 THE BEHAVIOR OF THE SOFT COMPONENT OF COSMIC RAYS UNDER THICK LEAD LAYERS. O. Balea and E. Friedländer. Acad. rep. populare Romîne, Inst. fiz. atomică şi Inst. fiz., Studii cercetări fiz., 11: 515-19 (1960). (In Romanian)

An anomalous increase of the Rossi maximum previously reported by P. H. Stoker (Phys. Rev. 102, 516(1956)) is shown to be caused by a variation of the over-all acceptance efficiency of the counter batteries with distance from the lead layer. (auth)

9644 TRANSITION EFFECTS OF COSMIC RADIATION IN COMBINED ABSORBANTS. E. Friedländer. Acad. rep. populare Romîne, Inst. fiz. atomică şi Inst. fiz. Studii cercetări fiz., 11: 615-26(1960). (In Romanian)

The possibility of attenuating the soft component of cosmic radiation in relatively thin layers of material by the use of combined absorbants (lead followed by aluminum) was studied. If the thicknesses of the lead are small, experiment shows a strong attenuation of the Rossi maximum when a relatively thin layer of aluminum is added. If the thickness of the lead is greater (about 20 cm) a pronounced transition effect appears in the aluminum which can not be explained by the actual knowledge of cosmic radiation. The effect disappears when the lead layer is higher than or equal to 30 cm and is in strict correlation with the penetrating component of cosmic radiation. (tr-auth)

9645 THE SUDDEN INCREASE IN THE PHOTON COMPONENT OF COSMIC RADIATION ON MAY 4, 1960. S. Standil, R. P. Bukata, and F. K. Chin (Univ. of Manitoba, Winnipeg, Can.). Can. J. Phys., 39: 229-30(Jan. 1961).

Observations with a cosmic-ray monitor designed for the photon component are reported which were made in Winnipeg on the same day as the solar flare of May 4, 1960. The data were collected at 0500 to 1300 hr with and without the anticoincidence shield at 12 and 35 Mev and divided into P and C events, which are due to the photon component and μ mesons, respectively. The increases occur at the same time, 10:45 ± 15 min, as the increase noted by Rose. The 10 to 15% increase for the C component agrees with the reported meson telescope data. The increases for the P component are much smaller than those reported for the neutron component, and the P increase above 35 Mev is larger than that in the range 12 to 35 Mev. (D.L.C.)

9646 THE INFLUENCE OF SMALL FLARES ON THE INTENSITY OF THE NEUTRON COMPONENT OF COSMIC RAYS. P. Chaloupka, M. Jireš (Laboratory of Physics, Slovak Academy of Sciences, Bratislava), and T. Kowalski. Czechoslov. J. Phys., B10: 769-71(1960). (In English)

The increase in the intensity of the neutron component of cosmic rays due to small solar flares as reported by Firor was investigated. The data analyzed were obtained by continuous recording of the neutron component on Lomnický Stit in 1958. Analysis showed no increase in the neutron component of any statistical importance. Kolomeec's conclusion that there was an increase which followed the flare having an amplitude of about 1% and a duration of about 10 hr was explained by the daily variation. (M.C.G.)

9647 MIRROR AND AZIMUTHAL DRIFT FREQUENCIES FOR GEOMAGNETICALLY TRAPPED PARTICLES. D. A. Hamlin, R. Karplus, R. C. Vik, and K. M. Watson (Convair, San Diego, Calif.). J. Geophys. Research, 66: 1-4 (Jan. 1961).

For charged particles trapped in the geomagnetic field, the frequencies of the mirror oscillations ω_m and the azimuthal drift ω_d are defined as appropriate averages over the helical motion around the field lines and the mirror motion between reflection points in the two magnetic hemispheres. These integrals for ω_m and ω_d are evaluated numerically. Results are tabulated, illustrated, and represented by approximate analytical expressions. (auth)

9648 VARIATIONS IN RADIOCARBON CONCENTRATION AND SUNSPOT ACTIVITY. M. Stuiver (Yale Univ., New Haven). J. Geophys. Research, 66: 273-6 (Jan. 1961).

Variations in cosmic-ray intensities will produce variations in C^{14} production in the atmosphere. A comparison is made between variations in sunspot activity and fluctuations in C^{14} concentration during the past 13 centuries. Although a definite conclusion is not reached, the evidence given suggests some correspondence between sunspot activities and C^{14} concentration in the atmosphere. (auth)

9649 OBSERVATION OF A SOLAR BREMSSTRAHLUNG BURST OF 1926 UT, AUGUST 11, 1960. J. R. Winckler, T. C. May, and A. J. Masley (Univ. of Minnesota, Minneapolis). J. Geophys. Research, 66: 316-20 (Jan. 1961).

Balloon detector data are given for a radiation increase at 1926 UT, August 11, 1960, which is identified as a bremsstrahlung burst on the sun during a class 2+ flare. The data, collected above Minneapolis, Minn., and Fort Churchill, Manitoba, Canada, indicate low-energy x rays with a mean energy of ~30 kev. The correlations between this burst with radiofrequency and optical observations are given. It is concluded that the burst is correlated with Type III radio emission, which confirms De Jager's prediction of an association between flare x rays and Type III bursts. (D.L.C.)

9650 OBSERVATIONS OF THE COSMIC-RAY EQUATOR IN THE PACIFIC OCEAN AREA. Richard A. Hubach (Univ. of California, Berkeley). J. Geophys. Research, 66: 321-2(Jan. 1961).

A latitude survey was made of the nucleonic component of the cosmic radiation intensity in the Pacific Ocean. A two-section neutron monitor made three crossings of the cosmic-ray equator on a ship course between San Francisco and Sydney and determined the equator to be 4°30′ ± 1°30′ S at 143° W and 3°30′ ± 2°00′ S at 166° W. These data are compared with the dipole and dip equators and the theoretical cosmic-ray equators calculated by Rothwell and Quenby and Webber. (D.L.C.)

9651 A MONTE-CARLO CALCULATION OF THE PRODUCTION SPECTRUM OF MESONS IN JETS. M. Marcu and M. Spîrchez (Inst. of Atomic Physics, Bucharest). Nuclear Phys., 21: 526-7(Dec. (1) 1960). (In English)

A sample of 200 values of the momentum of the secondaries in high-energy meson jets was computed by means of a Monte Carlo procedure, starting from experimental observed facts such as the Gaussian distribution of log p_T and the isotropy in the emitting center system. The shape of the spectrum of p-values did not agree with dp/p^2. (auth)

9652 ON THE INTERPRETATION OF COSMIC RAY μ-MESON DATA. D. Stern (Univ. of Maryland, College Park). Nuovo cimento (10), 18: 1-8 (Oct. 1, 1960). (In English)

An analysis was made of the extent to which primary interactions can be investigated using data obtained from cosmic-ray μ-mesons. The analytic dependence of the μ-meson flux at various depths and energies is developed, and computations of the energy distribution of pions in primary interactions are made. The results agree with a power law lab-system energy distribution. (auth)

9653 PRELIMINARY REPORT ON COSMIC RAY INTENSITY DURING MAGNETIC STORMS IN JULY 1959. J. G. Roederer, O. R. Santochi, J. C. Anderson, J. M. Cardoso, and J. R. Manzano (Comisión Nacional de Energía Atómica, Buenos Aires, Argentina). Nuovo cimento (10), 18: 120-30 (Oct. 1, 1960). (In English)

The cosmic-ray intensity variation during three magnetic storms of July 1959 is analyzed. Data from neutron monitors at Mina Aguilar (4000 m o.s.l. at 12°S geomagnetic latitude), Buenos Aires (0 m o.s.l., 23°S) and Ellsworth (0 m o.s.l., 67°S) were used. A method is described which gives detailed information on the variation of the primary cosmic-ray spectrum during magnetic storms. The method is applied to the present case, giving the results: the shape of the primary variation spectrum responsible for the July storms was approximately the same as that of the May 1959 storm. During the recovery of the second storm, an injection of considerable intensity of low-energy particles was found. The time dependence of this extra flux is determined. During the slow recovery after the last storm, the primary variation spectrum changes its shape in a similar way as in the May storm recovery. The correlation of these effects with geomagnetic activity is shown. (auth)

9654 ANALYSIS OF COSMIC RAY INTENSITY TIME-DEPENDENCE RECORDED AT MINA AGUILAR DURING JULY 1959. J. G. Roederer, O. R. Santochi, J. C. Anderson, J. M. Cardoso, and J. R. Manzano (Comisión Nacional de Energía Atómica, Buenos Aires, Argentina). Nuovo cimento (10), 18: 131-5 (Oct. 1, 1960). (In English)

Intensity variations of nucleonic component at Mina Aguilar (4000 m o.s.l., 12°S geomagnetic latitude) are analyzed as a function of time for July 1959 storms. It is suggested that the intensity behavior is caused by a linear addition of three independent Forbush decreases of different amplitudes and relaxation times, but of approximately the same form of primary variation spectrum at high energies. The slow recovery after the third storm is mainly determined by the relaxation time of the second storm. (auth)

9655 COSMIC RAY INTENSITY VARIATIONS DURING THE MAGNETIC STORM IN MAY 1959. J. R. Manzano, J. G. Roederer, and O. R. Santochi (Comisión Nacional de Energía Atómica, Buenos Aires, Argentina). Nuovo cimento (10), 18: 136-46 (Oct. 1, 1960). (In English)

Cosmic-ray intensity during the May 1959 magnetic storm is analyzed, using neutron monitor and cubic telescope data from Mina Aguilar, Buenos Aires, Ushuaia, and Ellsworth (Antarctica). The primary variation spectrum is estimated according to a method outlined by Roederer et al. The intensity behavior during recovery is analyzed and the following results are obtained: The primary variation spectrum, acting until the 18th of May, had an approximate form given by $\delta D/D = \delta k(t) \cdot E^{-0.5}$, valid up to very high energies. On the 18th, the spectrum changed its shape at low energies (< 2 Bev), in a similar way as it occurred during the July 1959 storm recovery. This change may be interpreted as an additional removal of low-energy particles, which lasted at least until the end of the month. On May 14, the intensity variation was quite peculiar, in spite of being a quiet day from the solar and geomagnetic point of view. A world-wide decrease occurred, with a superposed 10-hr lasting increase, which is particularly high at Ellsworth (9% in the neutron monitor, 2% for the cubical telescope). It is shown that Ellsworth was located in a 04 impact zone for a simultaneous solar event. On the 24th, a world-wide, small Forbush decrease occurred, associated with a magnetic storm and a decrease in the horizontal component of the magnetic field. The Forbush decrease, which shows a strong longitude dependence, corresponds to a primary variation spectrum which has the shame shape as that responsible for the general recovery acting at the time, i.e., after the low energy change on the 18th. (auth)

9656 MOMENTUM SPECTRUM OF MUONS. W. Pak, S. Ozaki, B. P. Roe, and K. Greisen (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 121: 905-7(Feb. 1, 1961).

The momentum spectrum was measured with a magnetic spectrometer for cosmic particles incident vertically and at 68° zenith angle, in the range 2 to 70 Bev/c. The apparatus discriminated strongly against all particles but muons. The vertical muon spectrum was found to be in good agreement with the results reported by Pine et al., and by Ashton et al. No comparable data at 68° were previously published. Assuming muon creation to occur entirely through pion decay, a single pion production spectrum accounted for the muon spectra at both zenith angles. The muon positive excess at energies of 8 to 50 Bev was also obtained. The results, while in general agreement with those of other workers, confirmed the expected tendency for the positive excess to decrease with energy. (auth)

9657 COSMIC-RAY NEUTRON INCREASE FROM A FLARE ON THE FAR SIDE OF THE SUN. H. Carmichael (Atomic Energy of Canada Ltd., Chalk River, Ont.), J. F. Steljes, D. C. Rose, and B. G. Wilson. Phys. Rev. Letters, 6: 49-50(Jan. 15, 1961).

An injection of solar cosmic radiation, which occurred on November 20, 1960, seemed to have originated in a large unseen flare which occurred at a solar longitude some 120°W of the center of the solar disk or about 30° behind the west limb of the sun. At 2100 hr U.T. on November 20, a sudden increase in neutrons was observed at Sulphur Mountain, Deep River, and Churchill, Canada. The characteristic shape of the increase, the fact that it was relatively much larger at a mountain station, and its absence in a meson telescope at the same station indicated that it was produced by solar protons. (M.C.G.)

9658 LIMITATIONS ON SPACE FLIGHT DUE TO COSMIC RADIATIONS. Howard J. Curtis (Brookhaven National Lab., Upton, N. Y.). Science, 133: 312-16(Feb. 3, 1961).

The biological and physical significance of the Van Allen radiation belts and cosmic radiation on the safety of space flight is discussed. It is concluded that below the Van Allen belts no shielding is needed. It is probably impractical to shield a vehicle for a stay in the inner belt for more than an hour, but passage through the belt without serious harm should be possible. Shielding for the outer belt is possible but would have to be quite heavy for a stay of more than a few hours. Primary cosmic radiation is not enough for a serious dose, even for exposures of a few weeks. (T.R.H.)

9659 SCANDIUM-45 AS REACTION PRODUCT OF COSMIC RADIATION IN IRON METEORITES. II. H. Wänke (Max-Planck Inst. für Chemie, Mainz, Germany). Z. Naturforsch. 15a, 953-64 (Nov. 1960). (In German)

By means of neutron activation, the scandium concentration in a series of ion meteorites was measured. From the ratio with other spallation products of cosmic radiation, such as helium and neon, it was established that scandium in iron meteorites originates almost exclusively by the effect of cosmic radiation on the iron core. Whereas for natural scandium, which is not produced by the cosmic radiation, a value of 2×10^{-10} g Sc/g was found; the cosmogenic scandium increases up to a value of 4.6×10^{-9} g Sc/g. In the case of helium and other rare gases formed by the action of cosmic radiation on the meteorite, loss by diffusion can not be completely excluded; but no such loss is possible with scandium. Scandium, with the mass number 45, is only 11 mass numbers below iron and is produced with a very high production cross section by particles with relatively low energy. Scandium in iron meteorites is considered as a monitor for particles from 200 to 1000 Mev. From the relative concentration of scandium to helium, which is found in meteorites in various concentrations, it was possible, by comparison with the theoretically predicted concentrations, to calculate the least percentage fraction of particles with energy under 1 Bev in the total intensity of cosmic radiation. It was proved that in primary cosmic radiation at least 2.1 times as many particles with energy under 1 Bev must be present as particles with energy over 1 Bev. For the total intensity, a value of 0.65 particles/cm^2 sec steradian was found. Both estimates on the total time that the meteorites were exposed to cosmic radiation and on the space crossed by the meteorites were mean values. (tr-auth)

9660 INVESTIGATION OF AZIMUTHAL EFFECTS IN MESON SHOWERS PRODUCED BY 9 BeV PROTONS. E. M. Fridlaender (Inst. of Nuclear Physics, Academy of Sciences, Rumania). Zhur. Eksptl'. i Teoret Fiz., 39: 965-9(Oct. 1960). (In Russian)

A statistical method is proposed for treating data on the azimuthal distribution of particles of low-multiplicity meson showers. It is shown that an azimuthal effect appears in showers produced by cosmic rays but not in showers produced by 9 Bev protons. (auth)

9661 POLARIZATION OF COSMIC RAY μ^+-MESONS. V. V. Barmin, V. P. Kanavets, and B. V. Morozov. Zhur. Eksptl'. i Teoret Fiz., 39: 986-90(Oct. 1960). (In Russian)

Geiger and scintillation counter sets were used to measure the degree of polarization of cosmic ray μ^+ mesons of various energy. The energy of the μ^+ mesons was determined from the mean range in a copper and lead filter placed above the arrangement. The measurements were performed at sea level. The cosmic μ^+ meson polarizations obtained for μ^+ mesons possessing momenta 0.45, 0.9, and 1.7 Bev/c were respectively 0.23 ± 0.10, 0.37 ± 0.11, and 0.31 ± 0.10. (auth)

9662 INTERPRETATION OF EXPERIMENTAL DATA ON SPECTRA OF ELECTRON–PHOTON CASCADES WITH $>10^{12}$ ev AT UPPER LAYERS OF THE ATMOSPHERE. S. I. Nickol'skiĭ and Yu. A. Smorodin (Inst. of Physics, the Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1156-7(Oct. 1960). (In Russian)

An explanation is offered for data presented at the Moscow Conference on Cosmic Radiation, Moscow, 1959, which show a considerable difference between electron–photon cascade spectra ($\sim E^{-4}$ dE) and the primary cosmic radiation spectra ($\sim E^{-2.7}$ dE) observed at 10 to 12 km elevation. The explanation engages an hypothesis on variations of elementary particle interactions at 10^{14} to 3×10^{14} ev. The total ($>10^{12}$ ev) electron and photon flux at the indicated elevation was calculated and the energy spectra of electron–photon cascades detected in photoemulsions and ionization chambers were plotted. The energy flux measured with photoemulsions exceeds the energy measured with ionization chambers. In order to correlate the data it was assumed that a large portion of $>10^{12}$ ev electrons and photons observed in photoemulsions enter in groups. Hence, the energy spectrum of such groups, when recorded by an ionization chamber, should not be expressed by a continuous relation, but starting at 10^{13} to 5×10^{13} ev should show a certain sloping area. This area, expanded 3 to 5 times, shows an energy spectrum of electron–photon showers identical to the primary cosmic radiation. Thus, it is obvious that such a tendency in spectrum variations corresponds to the assumption on spectrum variations in the electron–photon component at $\gtrsim 10^{14}$ ev. A large number of $>10^{12}$ ev electrons and photons with angular divergence of $\sim 10^{-5}$ rad was also observed in the photoemulsion. Descriptions of these variations by the statistical model was complicated by the cross sections in particles scattering at $\lesssim 10^8$ ev/c, the ratio between $\pi^\pm$ and π^0 mesons, and by a "monochromatic" soft component. (R.V.J.)

9663 CALCULATION OF AVERAGED CHARACTERISTICS OF EXTENSIVE ATMOSPHERIC COSMIC RAY SHOWERS. S. I. Nikol'skiĭ and A. A. Pomanskiĭ (Lebedev Inst. of Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1339-46(Nov. 1960). (In Russian)

The results of calculation of nuclear-cascade showers containing a given number of electrons at the observation level are presented. The distribution of the production heights is determined for extensive air showers containing total numbers of particles of 10^4, 10^5, and 10^6 at sea level and at a height of 3860 m above sea level. The characteristics averaged over various production heights are compared with the experimental data. (auth)

9664 ANGULAR DISTRIBUTIONS OF HIGH ENERGY μ-MESONS IN THE ATMOSPHERE AND THEIR PRODUCTION MECHANISM. G. T. Zatsepin and V. A. Kuz'min (Lebedev Inst. of Physics, Moscow). Zhur. Eksptl'. i Teoret. Fiz., 39: 1677-85(Dec. 1960). (In Russian)

The kinetic equation for μ mesons in the atmosphere, in which decay and energy losses are taken into account, was solved. The angular distribution of 10^{11} to 10^{14} ev μ mesons in the atmosphere was computed for two possible production mechanisms: $\pi \rightarrow \mu + \nu$ and $K \rightarrow \mu + \nu$ decays. The results indicate that in the 10^{11} to 5×10^{12} ev energy range the μ meson angular distributions significantly depend on the production mechanism. (auth)

Criticality Studies

9665 (K-709) A PROPOSED METHOD OF EVALUATING CRITICAL MASS HAZARDS AT LOW ASSAYS. R. L. Macklin (Carbide and Carbon Chemicals Div. K-25 Plant, Oak Ridge, Tenn.). Dec. 27, 1950. Decl. Mar. 7, 1960. 19p. Contract W-7405-eng-26.

A method is given for calculating safe volumes from the available critical mass data. Formulas and procedures are developed for performing such a calculation for solid uranium compound mixed or dissolved in hydrogeneous liquids. (auth)

9666 (NAA-SR-Memo-5520) OMRCF CALCULATIONS FOR THE 6" LATTICE WITH AND WITHOUT THIMBLES AND FOR THE 5½" LATTICE. J. L. Watts and R. A. Blaine (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 21, 1960. 22p.

Calculations were made of the critical mass and metal and isothermal temperature coefficients for the Organic Moderated Reactor Critical Facility loaded with 12-plate fuel elements in a 6-in. lattice, with and without control rod thimbles and in a 5½-in. lattice without thimbles. The results indicate that the 2-group theory is probably adequate for coefficient studies, but the 15-group theory is far better for criticality calculations. While the 2- and 15-group metal temperature coefficients differ by a factor of 2, the agreement for the isothermal coefficients is very good. (T.R.H.)

9667 (RFP-213) PLEXIGLAS REFLECTED ASSEMBLIES OF PLUTONIUM. C. L. Schuske, D. F. Smith, and C. L. Bell (Dow Chemical Co., Rocky Flats Plant, Denver). Jan. 10, 1961. 7p. Contract AT(29-1)-1106.

A compilation is presented of critical extrapolations of subcritical neutron multiplication measurements made on assemblies of plutonium metal tamped with Plexiglas. In addition to this compilation, recent data are reported on a 20- by 20-in. slab of metal tamped with Plexiglas. A simple empirical equation of the form $(\sqrt{A}-\sqrt{A_0})(h-h_0) = C$ was found which fits the data and predicts the infinite slab and cylinder dimensions. (auth)

Elementary Particles and Radiations

9668 (AFOSR-TN-60-962) ON THE FERMI-YANG THEORY OF THE PION. Scientific Note No. 4. W. Thirring, K. Baumann, and P. G. O. Freund (Vienna. Universität. Institut für Theoretische Physik.). June 10, 1960. 7p. Contract 61(052)-265.

It is proposed to reduce the strong interactions to the universal weak interaction, by considering them as high-energy phenomena of the strongly energy-dependent weak interaction. According to Fermi and Yang the pion is assumed to be a nucleon-antinucleon bound state. A method presented previously is used to solve a Bethe-Salpeter equation. The bound state wave function is normalized, and the pion-nucleon coupling-constant is calculated. The latter turns out to be of the order unity, although a weak interaction between the fermions is used. (auth)

9669 (ARL-TR-60-314) A PROGRAM FOR THE NUMERICAL INTEGRATION OF THE BOLTZMANN TRANSPORT EQUATION—NIOBE. S. Preiser, G. Rabinowitz, and E. deDufour (Nuclear Development Corp. of America, White Plains, N. Y.). Dec. 1960. 56p. Project No. 7112. Contract AF33(616)6184.

A code (NIOBE) for numerically integrating the time-independent neutron or gamma-ray Boltzmann transport equation was written for the IBM-704. The code will calculate angular distributions, total fluxes, and currents for neutrons (or photons) as a function of energy (or wavelength) in a finite, multilayered, spherically symmetric configuration. (auth)

9670 (JINR-D-615) A CONVERGENT SET OF INTEGRAL EQUATIONS FOR THE SINGLET PROTON-PROTON SCATTERING. S. Ciulli and J. Fischer (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1960. 13p.

Elastic nucleon-nucleon scattering is studied using the two dimensional spectral representation of Mandelstam. The convergence problem arising from the combination of the forward dispersion relation with the unitarity condition on the physical cut, is solved by use of a conformal transformation. (auth)

9671 (NP-9503) PHOTON DECAY OF HYPERONS. Prem Prakash and A. H. Zimerman (Rio de Janeiro. Centro Brasileiro de Pesquisas Físicas). 1960. 25p. (Notas de física Vol. VI, No. 5, p.141-63).

The weak photon decay of hyperons in which the initial hyperon decays into a baryon and a photon is examined. The lowest order perturbation theory estimates on the three parameters required to describe the angular distribution of the decay products is made, assuming weak derivative coupling (vector minus axial vector) for hyperon nucleon pion interaction together with the $|\Delta \vec{I}| = \frac{1}{2}$ rule in the isotopic spin space. The theoretical rate of decay seems to be higher than the experimentally observed rate. (auth)

9672 (NP-9727) STATISTICAL THEORY OF MULTIPLE PARTICLE PRODUCTION WITH ANGULAR MOMENTUM CONSERVATION. Z. Koba (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). October 1960. 33p.

A new formulation of the statistical theory of multiple particle production is investigated, in which the angular momentum of the system is strictly conserved and which can thus be applied to the analysis of peripheral collisions and the angular distribution of secondary particles. Fundamental formulas, simple examples, and some relevant remarks are presented. (auth)

9673 (ORNL-2990) THE DEPOLARIZATION OF NEGATIVE MU MESONS (thesis). Robert Alexander Mann (Oak Ridge National Lab., Tenn.). December 14, 1960. 152p. Contract No. W-7405-eng-26.

A discussion of the observed polarization of the negative mu mesons is presented. It is shown that the depolarization of the negative mu mesons may be explained by consideration of the processes attendant to the formation of mu-mesic atoms. The depolarization occurs when the mu mesons are initially captured into a highly excited bound state and in the subsequent transitions. As an essential preliminary to deducing the depolarization on capture the distribution of the mu mesons in initial states of the capturing atoms is determined. This distribution depends on the rate at which the mu mesons lose energy in the stopping process. The depolarization in the initial capturing event is due to the spin-orbit coupling; however, the extent of the depolarization in capture is strongly conditioned by the scattering preceding capture. It is shown that the mu mesons may be regarded as having random direction when they are captured. In the cascade subsequent to capture both radiative and Auger transitions are important. These are treated in an adequate manner and the final polarization of the mu mesons is derived theoretically. The circular polarization of the x rays emitted in the last stage of the cascade is discussed. It is found that the negative mu mesons should retain a polarization of 0.133 in the ground state of mu-mesic carbon. The results obtained are compared with the best experimental data available. The excellent agreement and the unambiguous nature of the analysis presented indicate the validity of the basic assumption that the mu mesons interact with matter in just the same manner as an electron. (auth)

9674 (ORNL-2998) THE SINGLE-SCATTERING APPROXIMATION TO THE GAMMA-RAY AIR-SCATTERING

PROBLEM. D. K. Trubey (Oak Ridge National Lab., Tenn.). Feb. 9, 1961. 22p. Contract W-7405-eng-26.

The result of a calculation using the single-scattering approximation with no exponential attenuation or buildup was compared to the results of a Monte Carlo calculation of the dose rate and number flux in air from a monoenergetic γ source. The comparison shows that the simple approximation is generally adequate for unshielded detectors. (auth)

9675 (TID-11648) NON-RELATIVISTIC PHASE-SHIFT ANALYSIS OF THE ELASTIC K^+-MESON-NUCLEON SCATTERING AND THE POLARIZATION OF THE RECOIL NUCLEON (thesis). Henry P. Smith (Tufts Univ., Medford, Mass.). June 1960. 63p.

Using some relatively straightforward techniques of non-relativistic quantum mechanics, an attempt was made to get a reasonable fit to some data for elastic K^+-N scattering at energies below the meson production threshold. Calculations were made which indicate that such a fit does not appear possible for a simple potential form of the type frequently employed in low-energy nucleon interactions. While the present data seem to have an anisotropy in the backward direction, the interpretation most often found is that of pure S-wave scattering. Assuming this anisotropy to be a real effect, a partial-wave analysis extending up to d-waves was made to get an approximate fit to the data. The scattering amplitude thus obtained yields a polarization of the recoil proton which was calculated and is reasonably consistent with the experimental scattering data. (auth)

9676 (UCRL-2706) NEUTRON PRODUCTION BY HIGH-ENERGY PARTICLES. Walter E. Crandall and George P. Millburn (California. Univ., Berkeley. Radiation Lab.). Sept. 29, 1954. Decl. May 3, 1960. Contract W-7405-eng-48.

From neutron-yield measurements made with a $MnSO_4$ detecting solution, the average number of neutrons produced per inelastic event is determined for a series of elements from lithium to uranium for 340-Mev protons, 190- and 315-Mev deuterons, 490-Mev He^3 ions, and 90- and 160-Mev neutrons. The results are analyzed in an attempt to understand the total yield measurements for thick targets and to explain the variation of yield with the atomic number of the target. (auth)

9677 THE SCATTERING OF SLOW PARTICLES IN NUCLEAR EMULSIONS. E. Friedländer. Acad. rep. populare Romîne, Inst. fiz. atomică, şi Inst. fiz., Studii cercetări fiz., 11: 633-43(1960). (In Romanian)

For the study of the scattering cross section at very low energies, a new method was proposed based on the angular distribution, at the end of the path, of tracks of an initially parallel beam after passing through a given layer of nuclear emulsions. The total effect of the multiple coulomb scattering along the length of the trajectory was calculated by taking into consideration the energy losses. The method is verified by measurements on protons. In the application of the method to the study of the scattering of π^+ mesons below 10 Mev, it was concluded that in this range of energies the cross section for the nuclear scattering shows a definite increase, agreeing with theoretical predictions. (tr-auth)

9678 ON THE STATE OF A FERMI-SYSTEM WITH CORRELATION OF PAIRS OF PARTICLES WITH PARALLEL SPINS. I. GROUND—STATE. Zygmunt Galasiewicz (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). Acta Phys. Polon. 19, 467-76(1960). (In English)

The solution of a compensation equation of dangerous graphs, for a system of interacting Fermi-particles, as an odd function of wave vectors is investigated. It is shown that this solution leads to the anomalous state, the energy of which is smaller than the energy of the normal state. The energy difference is equal to the binding energy of the pairs of fermions with parallel spin-moments. This anomalous state can exist in the presence of attractive Coulomb interactions. The elementary excitations are separated from the ground state by a gap the width of which depends on the direction of the wave vector. For the direction perpendicular to the spin direction, energy gap is zero and therefore the state cannot be superconducting. The binding energy of the pairs and the width of the energy gap are of the same order as in the theory based on the creation of pairs with antiparallel spin-moments, where in the expansion of the interaction term in spherical harmonics, the first coefficient is more than three times greater than the zero coefficient. In the absence of the magnetic field the total spin of a system is zero. In the presence of the magnetic field the total spin differs from zero. The paramagnetic susceptibility is calculated. (auth)

9679 AN ELEMENTARY DERIVATION OF THE FORMULAE FOR MULTIPOLE RADIATION. Bronisław Średniawa (Jagellonian University, Cracow, Poland). Acta Phys. Polon., 19: 477-85(1960). (In English)

Expressions for the field intensities of the different electromagnetic multipole radiations produced by electric charges and currents, as well as by electric and magnetic polarizations varying harmonically in time, are deduced by developing the retarded potentials into series. The formulas obtained are direct generalizations of the Rubinowicz-Sommerfeld formulas for dipole and quadrupole radiations and are valid in the wave zone. The general formulas for the field intensities are also given in tensor form. (auth)

9680 THE UNIVERSAL FERMI INTERACTION IN THE MUON CAPTURE. W. Majewski (Polish Academy of Sciences, Warsaw). Acta Phys. Polon., 19: 525-30(1960). (In English)

The angular asymmetry of neutrons from the capture of polarized μ mesons in complex nuclei is estimated, assuming the applicability of the Fermi gas model of the nucleus. It is shown that the four-fermion V−A interaction, together with the conserved current hypothesis, lead to considerable asymmetry. (auth)

9681 AN EXTENSION OF THE INHOMOGENEOUS LORENTZ GROUP. Y. Ahmavaara. Ann. Acad. Sci. Fennicae. Ser. A VI, No. 60, 1-30(1960). (In English)

The theory of the inhomogeneous Lorentz group is investigated in view of the possibility of finding, using only formal group-theoretical arguments, an extension of this group which could have properties in common with the "true" elementary particles group. It is shown that an extension, suggested by such formal arguments and connected with the adjoint representation, can be constructed which gives a particle model with the following properties: (1) a distinction between the "heavy" and the "light" particles appears and (2) an "isotopic spin" is defined for the heavy particles which degenerates, in the case of the light particles, to a single pseudoscalar quantity. Among the mathematical preliminaries, some results concerning the canonical parametrization, 4-screws, adjoint representation, and classes of the Lorentz group are stated. (auth)

9682 MEASUREMENT OF SELF-ABSORPTION ALONG THE AXIS FOR A Co^{60} PREPARATION OF CYLINDRICAL SHAPE. K. K. Aglintsev, G. P. Ostromukhova, and E. A. Khol'nova. Atomnaya Energ. 10: 75-6(Jan. 1961). (In Russian)

The doses from and absolute activities of 2 to 15-mm cy-

lindrical Co^{60} sources were measured, and the self-absorption coefficient f was determined. A correlation of the obtained curves indicates good agreement between the formula $f = (1-e^{\mu l})/\mu l)$ (where μ is the linear coefficient of γ attenuation in cobalt, l is length) and the curve for 2 to 4-mm lengths. However, for longer sources the experimental and theoretical data do not coincide, possibly due to radiation scattering. (R.V.J.)

9683 THE ELECTRON ASYMMETRY IN THE BETA DECAY OF POLARIZED NEUTRONS. M. A. Clark and J. M. Robson (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Can. J. Phys., 39: 13-21(Jan. 1961). (AECL-1133)

The coefficient of the angular correlation between the electron direction and the neutron spin direction in the β decay of the neutron was measured using a beam of polarized neutrons. The coefficient of this correlation is -0.09 ± 0.05. This implies that C_A/C_V, the ratio of the axial vector to vector coupling constants in neutron decay, is equal to -1.20 ± 0.12. (auth)

9684 THE ELECTROMAGNETIC STRUCTURE OF NUCLEONS. Jozef Kvasnica (Charles Univ., Prague). Československ. časopis pro fysiku, 10: 333-48(1960). (In Czech.)

Basic theoretical assumptions on which an experimental investigation of the electromagnetic structure of nucleons was based, and the results and possible interpretation of these experiments are discussed. (auth)

9685 MOVEMENT OF A PARTICLE ACCORDING TO THE THEORY OF THE SPIN GRAVITATIONAL FIELD. Marcel Lenoir. Compt. rend., 251: 2303-4(Nov. 21, 1960). (In French)

A class of equivalent Hamiltonians to formulate the laws of particle movement is given. One form of the conservation equations is derived. A method of M. A. Papapetrou is then applied to the study of the movement of a test particle. (tr-auth)

9686 MESON SCATTERING ON NUCLEONS I. I. Úlehla (Institute of Nuclear Research, Czechoslovakian Academy of Science, Prague). Czechoslov. J. Phys., B10: 701-14(1960). (In English)

It was assumed that nucleons are described by anomalous equations for particles with spin $\frac{1}{2}$. Meson(π) interactions with nucleons were taken in the form of pseudoscalar coupling. Meson(π) scattering on the nucleons was calculated in the first approximation of the perturbation theory. The cross sections were dependent on several interaction constants and on one free parameter. The course of the cross sections was determined for special values of the interaction constants and it is shown that by suitably choosing these constants qualitative agreement with experiment at lower energies can be obtained. (auth)

9687 TWO-QUANTUM ANNIHILATION OF POLARIZED POSITRONS. D. Babala (Czech Technical Univ., Prague). Czechoslov. J. Phys., 10: 628-32(Sept. 1960). (In English)

The cross section for the two-quantum annihilation-in-flight of partially polarized beams of β particles, obtained by using the polarization density matrix, is given. The annihilation of a longitudinally polarized positron with a transversally polarized electron is discussed. Computations are made in a center-of-mass system with summing over photon polarizations. (auth)

9688 THE POLARIZATION OF NUCLEI BY THE "EFFET SOLIDE" METHOD AND THE RELAXATION OF NUCLEAR SPINS DURING RAPID PASSAGE THROUGH A FIELD. J. Burget and M. Odehnal (Czechoslovak Academy of Science, Prague). Czechoslov. J. Phys., 10: 645-49 (Sept. 1960). (In English)

A description is given of an effect observed during the dynamic polarization of protons by the "effet solide" method, and its theoretical explanation is proposed. With alternating modulation of the magnetic field, not only polarization occurred at a resonance value of the field corresponding to the peak of the electron and nuclear resonance curve, which according to theory should not occur in such points, but there was also a change in its sign as a function of the direction of the passage through the field. This effect is explained by the "inertia" of the polarization during passage through a field in a time shorter than the spin-lattice relaxation time of the polarized nucleus. (auth)

9689 THE REAL PART OF THE ELASTIC SCATTERING AMPLITUDE FOR THE CASE OF HIGH ENERGIES. V. S. Barashenkov and Hsien Ting-chang (Joint Inst. for Nuclear Research). Doklady Akad. Nauk S.S.S.R., 134: 65-7(Sept. 1, 1960). (In Russian)

The energy dependence of the real part, D, of the elastic scattering amplitude for π mesons interacting with nucleons was found for the Bev energy range. The energy dependence of the cross section, as calculated, depends on the various assumptions about the structures of the interacting particles. The elastic scattering cross section was divided into diffractive and nondiffractive dispersion parts. The nondiffractive dispersion element was found to vary as a constant/E^2 as obtained from experimental data. From this D was calculated to be -0.3×10^{-13} cm. In the center-of-mass system of the π meson and the nucleon the real part varied as $-0.22 \times 10^{-13}/E^{1/2}$ cm. Further refinements await measurements of the elastic scattering cross section for π mesons and nucleons for small scattering angles. (TTT)

9690 RADIATION BY FAST PARTICLES IN AN INHOMOGENEOUS MEDIUM. M. L. Ter-Mikaelian (Physical Institute, Academy of Sciences, Armenian S.S.R.). Doklady Akad. Nauk S.S.S.R., 134: 318-21(Sept. 11, 1960). (In Russian)

A mathematical investigation was made of the radiation emitted by a fast particle passing through an inhomogeneous medium. The case of a medium whose dielectric constant has a small perturbation which is periodic along the direction of motion was considered. From the conservation of energy and momentum and the requirement that the momentum taken up by the medium be quantized by virtue of its periodicity, there was established a resonance condition, i.e., a basic relationship between the radiation's frequency, its angle of emission, and the effective frequency of the perturbation encountered by the particle. This condition led to an energy threshold for the appearance of resonance radiation. The intensity of the first harmonic was calculated explicitly, starting with the macroscopic Maxwell equations for the inhomogeneous medium and determining in succession the vector potential, the Poynting vector flux, and finally the total number of photons of given frequency emitted per unit length. An analogous calculation gave the intensity of higher harmonics for a perturbation strong enough that they are important. Resonance radiation may be used for the detection of very high energy particles. Topics discussed briefly include: the application of the analysis to lamellar media with sharp boundaries; the conditions which permit the neglect of the influence of multiple scattering; and the calculation of the radiation produced by random inhomogeneities. (TTT)

9691 ASYMPTOTIC PROPERTIES OF A BOSON FIELD WITH GIVEN SOURCE. J. M. Cook (Argonne National Lab., Ill.). J. Math. Phys., 2: 33-45(Jan.-Feb. 1961).

Some mathematical questions are answered in the theory of quantized boson fields with given linear source distribution. It is proved that the total hamiltonian in the Fock representation is self-adjoint. Unitary operators governing the evolution of the system in the interaction picture are defined and conditions given for their weak and strong convergence at remote times. (auth)

9692 ON THE GENERAL THEORY OF THE APPROACH TO EQUILIBRIUM. II. INTERACTING PARTICLES. F. Henin, P. Résibois, and F. Andrews (Université Libre, Brussels). J. Math. Phys., 2: 68-90(Jan.-Feb. 1961).

The general method described in a recent paper by Prigogine and Henin [J. Math. Phys., 1: 349(1960)] is applied to a system of interacting particles. A full use is made of the diagram technique due to Prigogine and Balescu. The distribution function is Fourier analyzed and each Fourier coefficient is decomposed into two parts: one (ρ') whose evolution results from scattering processes and which obeys a diagonal differential equation; the second one (ρ''), whose evolution is due to direct mechanical interactions which build the correlation described by the Fourier coefficient. The ρ'' can be expressed in terms of functions ρ' corresponding to lower correlations. The velocity distribution function is studied first. Only scattering processes contribute to the evolution of this function. The equations obtained ensure evolution of this function to the correct equilibrium value at any order in the concentration C and the coupling constant λ. The asymptotic behavior of the Fourier coefficients which describe correlations among the particles are then studied. The part ρ' of these coefficients corresponding to scattering processes vanishes for large time. In other words, scattering processes play a fundamental role in the establishment of the correct velocity distribution function, but once this is achieved they become ineffective. The correct equilibrium correlations, which in equilibrium theory are described in terms of cluster diagrams, are built by direct mechanical interactions among the particles involved in the correlation. A detailed proof up to order C^2 is given. The extension to higher orders does not introduce any new feature. (auth)

9693 ON THE GENERAL THEORY OF THE APPROACH TO EQUILIBRIUM. III. INHOMOGENEOUS SYSTEMS. Frank C. Andrews (Université Libre, Brussels). J. Math. Phys., 2: 91-5(Jan.-Feb. 1961).

The evolution equation is derived for a singlet distribution function in a fluid containing macroscopic inhomogeneities. The equation, a generalization of the Boltzmann equation, derived from the Liouville equation, may be written formally to any order in either concentration or strength of interaction. It is found that f_1 is a functional only of itself and other f_1's. It is shown that initially present correlations are destroyed during the same relaxation time as in homogeneous systems. The equation can then be written formally to any order for a reduced s-particle distribution function f_s, which proves to be a functional of a product of f_1's, all the time dependence of the f_s being lodged in the f_1's for times greater than the relaxation time. (auth)

9694 SOME NONEQUILIBRIUM PROPERTIES OF A BOSE SYSTEM OF HARD SPHERES AT EXTREMELY LOW TEMPERATURES. Tai Tsun Wu (Harvard Univ., Cambridge, Mass. and Univ. of California, Berkeley). J. Math. Phys., 2: 105-23(Jan.-Feb. 1961).

The pseudopotential method is used to study a special type of flow for a Bose system of hard spheres. In the first-order approximation, the wave function of the entire system is assumed to be the product of identical single-particle wave functions, which in general are time-dependent. Such a flow is necessarily irrotational, and the single-particle wave function satisfies a Schrödinger equation with a nonlinear self-coupling term. On the basis of this equation of motion, the following properties of the Bose system are discussed: the effect of the rigid wall, the moment of inertia, the compressional wave, and a type of "vortex filament." In the second-order approximation, the wave function of the system is expressed in terms of two functions such that one of them describes the single-particle state suitable for most of the particles while the other one describes the pair excitations. The much more complicated equations of motion are found, but in this approximation the flow is no longer strictly irrotational. The compressional waves are also studied in the second-order approximation. (auth)

9695 MONOCHROMATIC PHOTONS WITH VARIABLE ENERGY OBTAINED BY ANNIHILATION IN FLIGHT OF POSITRONS. J. Miller, C. Schuhl, G. Tamas, and C. Tzara (Centre d'Etudes Nucléaires, Saclay, France). J. phys. radium, 21: 755-6(Oct. 1960). In French)

A photon monochromator using the annihilation in flight of positrons produced from high-energy electrons was installed at the linear electron accelerator at Saclay. The design of this monochromator is described. The electrons from the accelerator, slowed in a 2.2-mm-thick platinum target, produce photons, negatrons, and negatron-positron pairs. The screening magnets extract a beam of monoenergetic positrons. The positrons are annihilated in a 1-mm-thick lithium target. The positron spectrum obtained with a primary beam of 15 μamp electrons is shown. The isochromatism of the photons was confirmed by elastic scattering on the 15.11-Mev level of C^{12}. The relationship defining the number of annihilation photons per second was determined. The photon intensity is sufficient for the study of photon-nucleus interactions. (J.S.R.)

9696 CHERENKOV RADIATION. J. A. M. Cox (Instituut-Lorentz, Leiden). Ned. Tijdschr. Natuurk., 26: 204-15(July 1960). (In Dutch)

Cherenkov radiation is discussed from a microscopic and a macroscopic viewpoint. Some problems connected with the phenomenon are then briefly indicated. (J.S.R.)

9697 DIRECTIONAL CORRELATION OF MESONS IN A CASCADE DECAY OF BARYONS RESULTING FROM A BARYON-BARYON REACTION. A. Deloff and J. Wrzecionko (Inst. for Nuclear Research, Warsaw). Nuclear Phys., 21: 237-44(Nov. 5, 1960). (In English)

General expressions were obtained of the momentum directional correlation function of mesons resulting from the decay of baryons that were products of a baryon-baryon reaction. As a particular case, a reaction was examined in which both particles before reaction were unpolarized. Calculations were done assuming that particles before the reaction are in the S state only (low energy zero threshold collision) or final state baryons are in the S-state only (high threshold reaction). Several experimental possibilities for a determination of the relative intrinsic parity of baryons are discussed. (auth)

9698 WEAK INTERACTIONS IN THE THEORY OF ELEMENTARY PARTICLES WITH FINITE SPACE. I. S. Shapiro (Inst. of Theoretical and Experimental Physics, Academy of Sciences, Moscow). Nuclear Phys., 21: 474-91(Dec. (1) 1960). (In English)

A variant of the theory put forth by H. R. Coish is considered. Two additional quantum numbers are shown to arise in this theory. The selection rules obeyed by them make it possible to forbid the conversion of baryons into

leptons and the neutrino-less decay of muons into electrons. Combined inversion was found to be the only possible law of transformation of wave functions in the case of space reflections, provided Wigner's transformation law is accepted for time inversions. The spinor field theory proved to be essentially two-component. These results as well as the quantization of electric charge are a consequence solely of the finiteness of the space-time manifold, ruling out divergencies. (auth)

9699 RENORMALIZATION PROBLEM FOR VECTOR MESON THEORIES. A. Komar and Abdus Salam (Imperial Coll. of Science and Tech., London). Nuclear Phys., 21: 624-30(Dec. 3, 1960). (In English)

The renormalizability problem of the Yang-Mills theory of vector mesons with mass is considered. It is shown that the divergences of such a theory are those of the electrodynamics of charged vector mesons. This general feature is illustrated by direct calculation of the lowest order divergent diagrams. It is concluded that renormalizability of this theory seems rather unlikely. (auth)

9700 "MINIMAL PROPERTY" OF ELECTROMAGNETIC INTERACTION FOR SPIN $\frac{3}{2}$ PARTICLES. A. Komar (Imperial Coll. of Science and Tech., London). Nuclear Phys., 22: 101-3(Jan. 1961). (In English)

The possibility of the extended electromagnetic interaction for spin $\frac{3}{2}$ particles with terms in the Lagrangian depending directly on electromagnetic field tensor $F_{\mu\nu}$ is considered. It is shown that inclusion of such terms leads in all variants to a nonconsistent theory, thus making the minimal electromagnetic interaction the only one allowed. (auth)

9701 A CONTRIBUTION TO THE ANOMALOUS MAGNETIC MOMENTS OF THE BARYONS. T. T. Crow and W. G. Holladay (Vanderbilt Univ., Nashville). Nuclear Phys., 22: 164-7(Jan. 1961). (In English)

A method of calculation and results are presented for the fourth order one-pion, one-kaon contribution to the magnetic moments of the baryons. Static, charge-independent interactions of spin $\frac{1}{2}$ baryons with pseudoscalar kaons were assumed. For this calculation a renormalization program was formulated similar to that of Chew but in which the baryon mass differences were taken into account. Generally speaking, the contributions calculated were comparable to second order kaon contributions. Therefore, it would appear that more accurate and elaborate computations of these moments should incorporate combined effects of the pion and kaon fields. (auth)

9702 ELEMENTARY PARTICLE PHYSICS TODAY. R. H. Dalitz (Univ. of Sydney). Nucleus (Sydney), 6: No. 2, 15-20(Nov. 1960).

A survey of the current status of elementary particle physics is presented. Tables are given showing the total number of particles known today and their characteristics. The laws of charge independence, conservation of strangeness, conservation of baryons, and parity conservation are discussed. Strong and weak interactions are treated. The role of bubble chambers and other equipment in elementary particle physics is discussed. (D.L.C.)

9703 $\pi^0-\pi^-$ MASS DIFFERENCE AS DETERMINED FROM DOUBLE DALITZ PAIRS. N. P. Samios (Columbia Univ., New York). Nuovo cimento (10), 18: 154-9 (Oct. 1, 1960). (In English)

The π^-, π^0 mass difference was determined by measuring the momenta of two internally converted electron-positron pairs from π^0-decay. A total of 119 events gave a value $m_{\pi^-}-m_{\pi^0}=(4.69\pm0.07)$ Mev. (auth)

9704 PHOTOPRODUCTION OF PIONS ON KAONS. J. Dufour, M. Gourdin, and J. Trotin (Faculté des Sciences, Bordeaux, France). Nuovo cimento (10), 18: 160-77 (Oct. 1, 1960). (In French)

The Mandelstam technique is used in a treatment of photoproduction of π mesons on K mesons which is necessary for the study of photoproduction of K mesons on nucleons. By limitation to the lowest mass intermediate states and retaining only the magnetic dipole transition, one obtains for the two amplitudes due to the isovectorial part of the electromagnetic current two coupled Mushkelishvili-Omnes integral equations, and for the amplitude due to the isoscalar part one equation of the same type. These reduce to the Fredholm integral equations. Knowledge of the approximate solutions for photoproduction of π mesons on π mesons and the phase shifts P of meson π-meson K scattering allows a numerical solution. (tr-auth)

9705 PHENOMENOLOGY OF Σ-NUCLEON SCATTERING. M. T. Vaughn (Purdue Univ., Lafayette, Ind.). Nuovo cimento (10), 18: 178-90 (Oct. 1, 1960). (In English)

A discussion is given of some phenomenological aspects of Σ-nucleon scattering. It is noted that with Σ^+ beams likely to be available in the near future, triple-scattering experiments are only slightly more difficult than single-scattering experiments. A method of determining separately ^1S and ^3S phase shifts at low energies is noted. A discussion is given of the qualitative features of low-energy Σ-nucleon scattering to be expected if one or the other of the global symmetry models $G_{\pi\Sigma}\approx\pm G_{\pi N}$ is valid, and possibilities of distinguishing between the two cases are examined, utilizing the Mandelstam representation for the scattering amplitude, some consequences of which are derived in the appendix. Analytic properties of the partial wave amplitudes are deduced; it is found that owing to the unequal masses of Σ and nucleon, the singularities of the partial wave amplitudes do not all lie on the real axis in the complex plane of the energy variable. (auth)

9706 $\pi\pi$ INTERACTION IN PERIPHERAL πN COLLISIONS. D. I. Blokhintsev (Blohinčev) (Joint Inst. for Nuclear Research, Moscow). Nuovo cimento (10), 18: 193-4 (Oct. 1, 1960). (In English)

Recent experimental data on inelastic π-N interactions has made it possible to apply the nucleon model for a more fundamental evaluation of $\pi-\pi$ interactions. Since π mesons are pseudoscalar, the nuclear charge of nucleons and antinucleons is equal. Therefore in π-meson dissociation $\pi \rightsquigarrow N+\overline{N}$ a nuclear monopole is formed, and the interaction between this virtual pair and a π meson must be comparable to π-N or π-$\overline{N}$ interactions. In view of this, a previous estimate of the $\pi-\pi$ interaction cross section gives only the lower limit. It is found that the $\pi-\pi$ interaction contribution to inelastic π-N scattering accompanied by meson production is not small, therefore, this scattering may be used successfully for determining the $\pi-\pi$ interactions. (B.O.G.)

9707 THE INFLUENCE OF A POSSIBLE PION-PION INTERACTION ON THE PHOTOPRODUCTION OF CHARGED PIONS. B. De Tollis, E. Ferrari, and H. Munczek (Istituto di Fisica dell'Università, Rome). Nuovo cimento (10), 18: 198-202 (Oct. 1, 1960). (In English)

It is shown that the theoretical π^-/π^+ ratio predictions at 90° can be brought into better agreement with experiment by considering the presence of a $\pi-\pi$ interaction, which is supposed to take place in a resonant T = 1, J = 1 state. The interaction leads to a branch-cut in the photoproduction momentum transfer variable from $4\mu^2$ to ∞. Calcu-

lations were made for the interaction contribution to the total S-matrix element and the results were plotted with previous determinations for comparison. It is seen that: the introduction of the π–π interaction constant gives the required decreasing behavior to the π^-/π^+ ratio, which is more rapid at 300 Mev as an effect of the resonant 33-phase shift; and as far as the π^+-distribution at 90° is concerned, the behavior of the curve is unaltered. A variation of the parameters of the calculation does not influence the π^-/π^+ ratio. (B.O.G.)

9708 ON A CONTRADICTION BETWEEN EXPERIMENTAL RESULTS ON NUCLEON FORM FACTORS AND CERTAIN SYMMETRIES OF STRONG INTERACTIONS. Ph. Meyer and J. Prentki (CERN, Geneva). Nuovo cimento (10), 18: 203-6 (Oct. 1, 1960). (In English)

A number of the consequences of strong interaction symmetries on hyperon electromagnet properties have been deduced. Assuming that the interactions have N– Ξ symmetry, the N and Ξ fields are symmetrically coupled with π's and K's, and the N– Ξ mass difference is neglected, a theorem was developed. The consequence of the theorem was studied to determine whether the transition amplitude between states containing π, γ, and K vanish at all orders of the strong and electromagnetic interactions for a process in which the sum of the total number of initial and final mesons-π involved is odd. It is concluded that the assumed symmetries imply that the π-contribution to the isoscalar form factors of nucleons and hyperons vanish at all orders in strong interactions. It is emphasized that the N– Ξ symmetry is necessary to draw this conclusion. (B.O.G.)

9709 RECOMBINATION OF IONS AND ELECTRONS. N. D'Angelo (Princeton Univ., N. J.). Phys. Rev., 121: 505-7(Jan. 15, 1961). (MATT-51)

A process of electron-ion recombination is considered, involving three bodies (one ion and two electrons), in which an electron, as a result of a collision with another electron, loses enough energy to be captured in one of the excited electronic orbits of the ion and then ends in the ground state by emission of one or more light quanta. It is shown that such a process might account for the large values of the recombination coefficient found experimentally. (auth)

9710 MEASUREMENT OF THE ANNIHILATION-IN-FLIGHT CROSS SECTION AT 0° FOR 8.5-Mev POSITRONS. F. D. Seward, C. R. Hatcher, and S. C. Fultz (Univ. of California, Livermore). Phys. Rev., 121: 605-9(Jan. 15, 1961). (UCRL-6043)

The differential cross section at 0° for the annihilation in flight of 8.5-Mev positrons was measured. The positrons were created in a thick tantalum target which was bombarded by 20-Mev electrons from a linear accelerator. They were directed onto a beryllium target where annihilation occurred, and the annihilation photons were measured by use of a thick-crystal spectrometer. The measured value for the cross section is 1.3 ± 0.2 barns/steradian per electron, which is in agreement with theory. (auth)

9711 SEARCH FOR NEUTRINOLESS CONVERSION OF MUON INTO ELECTRON. R. D. Sard, K. M. Crowe, and H. Kruger (Univ. of California, Berkeley). Phys. Rev., 121: 619-23(Jan. 15, 1961).

A search was made for the hypothetical reaction in which a muon near a nucleus is converted into an electron without production of neutrinos. Negative muons were stopped in a copper target. A magnetic spectrometer at right angles to the beam transmitted particles of the momentum expected for the electron (about 90 Mev/c on entry into the spectrometer). A long scintillation counter at the output of the spectrometer gave a pulse corresponding to the emerging particle's energy loss. Selection by both momentum and pulse-height eliminated particles heavier than the electron and greatly reduced the accidental background. In the main run, three events meeting the selection criteria were recorded, while the expected number of accidentals is 0.23 ± 0.04. Various alternative processes that would produce accepted events were considered and found to give expectation values even smaller than that for accidentals. Without further experimentation, it cannot be decided whether or not the hypothetical reaction occurs, but an upper limit of $(4^{+3}_{-2}) \times 10^{-6}$ can be set on the ratio R of the reaction rate to that of normal absorption. (auth)

9712 PHOTODISINTEGRATION OF THE DEUTERON FROM 500 TO 900 Mev. H. Myers, R. Gomez, D. Guinier, and A. V. Tollestrup (California Inst. of Tech., Pasadena). Phys. Rev., 121: 630-5(Jan. 15, 1961).

The reaction $\gamma + d \rightarrow p + n$ was studied for photon energies between 500 and 900 Mev. Bremsstrahlung from the California Institute of Technology electron synchrotron was incident on a liquid deuterium target. Measurements of the energy and angle of the protons arising in the interactions were sufficient to establish that photodisintegration without pion emission occurred and also to determine the energy of the photon which gave rise to the detected proton. An excitation curve was obtained at 90° in the laboratory, and angular distributions were measured for photon energies of 500 and 700 Mev. The total cross section decreased smoothly from 7 μb at 500 Mev to 1 μb at 900 Mev. (auth)

9713 THEORY OF ELECTRON-PHONON INTERACTIONS. G. D. Whitfield (Columbia Univ., New York and International Business Machines Watson Lab., New York). Phys. Rev., 121: 720-34(Feb. 1, 1961).

The theory of the interaction of electrons and acoustic phonons in nonpolar crystals was formulated in terms of a new set of basis states, whose wave functions are essentially Bloch functions that deform with the lattice. The major part of the interaction may then be calculated in terms of the strain tensor rather than the displacement of the lattice. A result of the theory is a generalization of the deformation potential theorem. (auth)

9714 LIFETIME OF THE NEUTRAL PION. V. Glaser (European Organization for Nuclear Research, Geneva) and R. A. Ferrell. Phys. Rev., 121: 886-92(Feb. 1, 1961).

As Primakoff noted, the phenomenological coupling constant of the neutral pion with the electromagnetic field can be investigated by considering the photoproduction of neutral pions in an external Coulomb field. This is the inverse of the usual two-photon decay (one of the photons being provided by the external field). The relationship between the cross section and the free lifetime of the π^0 was derived. Although the total cross section was small, it was found at high energy that the differential cross section was strongly peaked near the forward direction. The peak cross section was proportional to the fourth power of the photon energy. It was this feature that made possible an experimental determination of the lifetime by the photoproduction method to an accuracy of about 10%. A minimum photon energy of 1 Bev was required to avoid uncertainties in the nuclear form factor. A higher photon energy would be necessary only if the π^0 mean life was greater than 5×10^{-17} sec. The backgrounds to be expected from nuclear photoproduction were estimated and found to be sufficiently small. In particular, the interference between the coherent nuclear π^0 photoproduction and the Primakoff process was not excessive. (auth)

9715 CHARGE-EXCHANGE SCATTERING OF NEGATIVE PIONS BY HYDROGEN AT 230, 260, 290, 317, AND 371 Mev. John C. Caris, Robert W. Kenney, Victor Perez-Mendez, and Walton A. Perkins, III (Univ. of California, Berkeley). Phys. Rev., 121: 893-904(Feb. 1, 1961).

The differential cross section for charge-exchange scattering of negative pions by hydrogen was observed at 230, 260, 290, 317, and 371 Mev. The reaction was observed by detecting one γ ray from the π^0 decay with a scintillation-counter telescope. A least squares analysis was performed to fit the observations to the function

$$(d\sigma/d\omega) = \sum_{l=1}^{5} a_l P_{l-1}(\cos\theta)$$

in the c.m. frame. The best fit to the experimental measurements required only s- and p-wave scattering. The least squares analysis indicated that d-wave scattering was not established in this energy range. (auth)

9716 BOSON CURRENTS IN THE THEORY OF WEAK INTERACTIONS. W. B. Zeleny and A. O. Barut (Syracuse Univ., N. Y.). Phys. Rev., 121: 908-16(Feb. 1, 1961).

A possible new method of introducing boson currents into the weak interaction is suggested. The Bose fields were assumed to obey the first-order Kemmer equation. In this way, the boson and fermion currents entered the interaction in a symmetric manner. Three coupling constants were introduced according to the degree of isotopic spin and strangeness symmetries of the currents. The interaction so obtained gave rise in a natural way to the $|\Delta T| = \frac{1}{2}$ selection rule and its violation, and also to fast pionic modes and slow leptonic modes of hyperon decay. First-order calculations were performed for K^+_{l3}, τ, and τ' decays. Calculations of the decay rates yielded sufficient information to determine the approximate magnitudes of the effective coupling constants. The first-order calculations were at variance with the experimentally uniform distribution of τ events in the Dalitz plot. (auth)

9717 SPIN-MOMENTUM CORRELATIONS IN POSITRON-ELECTRON SCATTERING. C. Fronsdal and B. Jakšić (European Organization for Nuclear Research, Geneva). Phys. Rev., 121: 916-19(Feb. 1, 1961).

The imaginary part of the fourth-order Bhabha ($e^+ - e^-$) scattering matrix element interferes with the (real) second-order matrix element, to produce a sixth-order dependence of the cross section on the spin of one of the particles (after summing over the spins of the other three particles). The process of extracting the imaginary part of the fourth-order matrix element is presented. (auth)

9718 DETERMINATION OF PION-PION SCATTERING AMPLITUDES SATISFYING DISPERSION RELATIONS AND UNITARITY. John W. Moffat (RIAS, Baltimore). Phys. Rev., 121: 926-32(Feb. 1, 1961).

A method was developed for determining the partial-wave scattering amplitude in terms of the unitarity condition and the known branch cuts and poles of the inverse amplitude. The method was applied to the problem of pion-pion scattering and an implicit solution to the pion-pion partial-wave amplitude was derived for any angular momentum state and for both elastic and inelastic scattering. With the aid of this solution the low-energy resonance behavior of the pion-pion scattering system was studied by neglecting all inelastic processes and concentrating on s and p waves. It was found that a p-wave resonance with a position and width required by nucleon electromagnetic structure can be determined in terms of two parameters. An iteration procedure is described that is applicable when the p wave dominates the equations, and this procedure determines the contribution of the unphysical cut. The first iteration of the unphysical cut was numerically integrated on the IBM 709, and the results showed that the shift of the resonance position due to the unphysical branch cut can be neglected. (auth)

9719 ROLE OF THE PERIPHERAL INTERACTION IN PROTON-PROTON COLLISIONS. Franco Selleri (European Organization for Nuclear Research, Geneva). Phys. Rev. Letters, 6: 64-6(Jan. 15, 1961).

It was suggested that the inelastic scattering of any particle on a target nucleon may be dominated by the exchange of one single virtual pion. Analysis of experiments showed that there is good evidence for such a mechanism when the incoming particle is a π meson or a nucleon. The cross section for the process $p + p \rightarrow p + n + \pi^+$ was calculated under the assumption of dominating peripheral interaction. The peripheral model agreed well with experimental energy spectra while a statistical spectrum failed to explain the three main features of the distribution: strong peaking at low energy, a broad bump at high energy, and the minimum between them. The total cross section was predicted to be 12 mb and its experimental value was 16.4 ± 0.7 mb. This indicated that something more than the peripheral interaction contributes to the process. (M.C.G.)

9720 INTERMEDIATE BOSON PRODUCTION IN PION-PROTON COLLISIONS. Norman Dombey (California Inst. of Tech., Pasadena). Phys. Rev. Letters, 6: 66-8 (Jan. 15, 1961).

The vector current part of the interaction $\pi^+ + p \rightarrow W^+ + p$ was investigated. It was found that if the Bowcock, Cottingham, and Lurié fit to the π-π resonance is correct, then the cross section should be of the order of 10^{-30} cm^2 for values of the W mass between four and five pion masses. It is also possible, if the 3-3 resonance is taken into account, that the cross section is still greater. (M.C.G.)

9721 BINDING ENERGY OF THE TRITON. G. Derrick (Univ. of Manitoba, Winnipeg), D. Mustard, and J. M. Blatt. Phys. Rev. Letters, 6: 69-70(Jan. 15, 1961).

A variational calculation was made of the binding energy of the triton using the same two-body nuclear force law that was used by Brueckner and Gammel and assuming that there are no specifically many-body forces. After varying some 40 parameters, a ground-state energy of less than -10 Mev was obtained for the triton and a value of 3.2×10^{-13} cm was found for the Coulomb radius. These values disagreed with the experimental values of -8.49 Mev and 2.26×10^{-13} cm, respectively. It was concluded that the combination of the Gammel-Brueckner potential with the assumption of superposition of two-body forces is inconsistent with the experimental data on the triton. (M.C.G.)

9722 THE REACTION $\gamma + \gamma \rightarrow \nu + \bar{\nu}$. Murray Gell-Mann (California Inst. of Tech., Pasadena). Phys. Rev. Letters, 6: 70-1(Jan. 15, 1961).

The reaction $\gamma + \gamma \rightarrow \nu + \bar{\nu}$ was found not to be induced by local coupling. The matrix element of the interaction was equal to the total four-momentum times a pseudoscalar bilinear in the field strengths of the two photons. Local weak interactions, to the lowest order in G, gave a vanishing rate for this reaction. (M.C.G.)

9723 COMPLETENESS OF QUANTUM MECHANICS AND CHARGE-CONJUGATION CORRELATIONS OF THETA PARTICLES. D. R. Inglis (Argonne National Lab., Ill.). Revs. Modern Phys., 33: 1-7(Jan. 1961).

The possibility of using measurements made on a system to give information about a previous interaction with a second system is examined. The properties of the quantum

mechanical formalism describing θ particles are studied in terms of an analogy based on a descriptive treatment of Bohm's two-spin model. The classical and quantum treatments of the spin uncertainty are treated, and the system consisting of two particles, each experiencing a measurement, is compared with the system of one particle undergoing two successive Stern-Gerlach measurements. The question of the completeness of the formalism in a physical sense, raised by Einstein, Podolsky, and Rosen, is discussed, and the meaning of separating a system into two parts is examined. The limitation of classical concepts by quantum mechanics is considered. The situation of a combined system with S = 0 in a homogeneous magnetic field disintegrating into two particles which emerges from the field at different times is treated; its triplet term is found to appear and disappear with a frequency given by the difference of the two Larmor frequencies. The probability that both particles in θ pairs in $p\text{-}\bar{p}$ annihilation are antitheta is calculated, and its implications for the question of completeness are discussed. (D.L.C.)

9724 MATRIX REPRESENTATION OF POLARIZATION. William H. McMaster (Univ. of California, Livermore). Revs. Modern Phys., 33: 8-28(Jan. 1961). (UCRL-5496)

The use of density matrix and Stokes parameters to describe polarization enables representation of cross sections of polarization-sensitive interactions in matrix form to be made. An extensive treatment of this representation mode is presented for photons, electrons, neutrons, and for photon-electron interactions. (D.L.C.)

9725 THE RATIOS OF UNITARITY BETWEEN SCATTERING MATRIX PARAMETERS FOR ELASTIC INTERACTIONS OF PARTICLES WITH ARBITRARY SPIN. I. Brendush. Rev. phys., Acad. rép. populaire Roumaine, 5: 169-80(1960). (In Russian)

The ratios of unitarity between scattering matrix parameters for elastic interactions of particles with arbitrary spins S_1 and S_2 were analyzed. The developed ratios do not have explicit modes but are expressed as a system of integral equations with scattering matrix parameters as unknown functions and angles describing the beam direction before and after interactions, as unrelated variables. (R.V.J.)

9726 SEPARATED 1.17-BEV/c K^- MESON BEAM. Phillippe Eberhard, Myron L. Good, and Harold K. Ticho (California. Univ., Livermore. Lawrence Radiation Lab.). Rev. Sci. Instr., 31: No. 10, 1054-63 (Oct. 1960). (UCRL-8878(Rev.))

A description is given of the design and testing of a 1.17-Bev/c separated K^- beam designed in the fall of 1958 in connection with a 15-in. hydrogen bubble chamber experiment. At the target the K^-/π^- ratio was 1/140. At the chamber, 4.0 K^--meson decay lengths from the target, and after two stages of electromagnetic separation, the K^-/π^- ratio was 12.5, corresponding to a total pion suppression by a factor of about 10^5. The K^- flux at the chamber was 0.87 K^- mesons per 10^{10} protons impinging on the target. (auth)

9727 REMARKS ON THE ADIABATIC INVARIANCE OF THE ORBITAL MOMENT OF CHARGED PARTICLES. G. Backus, A. Lenard, and R. Kulsrud (Mass. Inst. of Technology, Cambridge and Princeton Univ., N. J.). Z. Naturforsch. 15a, 1007-09 (Nov. 1960). (In German)

The Hertweck and Schlüter formula for the relative variations of the orbital moment of a charged particle in a homogeneous magnetic field slowly changing with time (Z. Naturforsch. 12a, 844(1957)) gives a class of field equations for which the motion equations are exactly integrable. This class of equations is discussed by means of an example. (J.S.R.)

9728 DETERMINATION OF THE π-MESON-NUCLEON COUPLING CONSTANT FROM THE np-ELASTIC SCATTERING DIFFERENTIAL CROSS SECTIONS. N. S. Amaglobeli, Yu. M. Kazarinov, S. N. Sokolov, and I. N. Silin. Zhur. Eksptl'. i Teoret Fiz., 39: 948-53(Oct. 1960). (In Russian)

An analysis of experimental data on n-p scattering at energies 90, 380 to 400 and 630 Mev in which account was made for the existence of two poles in the real part of the n-p scattering amplitude was performed with the aim of determining the π meson-nucleon coupling constant. It is shown that within the experimental errors the employed data do not contradict the value $f^2 = 0.08$. (auth)

9729 TRANSITION RADIATION IN THE CASE OF A DIFFUSE BOUNDARY BETWEEN TWO MEDIA. A. Ts. Amatuni and N. A. Korkhmazyan (Inst. of Physics, the Academy of Sciences, Armenian S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1011-19(Oct. 1960). (In Russian)

The transition radiation of a charged relativistic particle was considered in the case of a diffuse boundary between two media. General formulas were derived for the main part of the radiation and a detailed study was made of the case when the size of the diffuseness region z_0 is much smaller than that of the regions of formation of the transition radiation in the two media R_0 and R_c. The cases when $z_0 \gg R_0 > R_c$ and $R_c \ll z_0 \ll R_0$ were also investigated. (auth)

9730 INELASTIC MAGNETIC SCATTERING OF SLOW NEUTRONS ON PHONONS. B. M. Khabibullin (Inst. of Physics and Technology, the Kazan Branch of the Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1027-30(Oct. 1960). (In Russian)

The differential cross section for inelastic scattering of neutrons on phonons due to magnetic interaction of the neutrons with the spin system of the paramagnet was estimated. A value of the cross section $d\sigma/d\Omega \approx 10^{-27}$ cm^2 was obtained. (auth)

9731 DETERMINATION OF THE RELATIVE PARITY OF Σ^0 AND Λ PARTICLES FROM THE $\Sigma^0 \rightarrow \Lambda + e^+ + e^-$ REACTION. B. N. Valuev and B. V. Geshkenbein. Zhur. Eksptl'. i Teoret Fiz., 39: 1046-8(Oct. 1960). (In Russian)

The correlation of the polarizations of the Σ^0 and Λ particles and electron-positron pair in the reaction $\Sigma^0 \rightarrow \Lambda + e^+ + e^-$ depending on the relative Σ^0 and Λ parities was considered. The correlations for a positive and negative relative parity were significantly different. In the presence of Σ^0 particles polarized during their production, a measurement of the indicated correlation may be a convenient means for determining the relative Σ^0 and Λ parities. (auth)

9732 ON RESONANCE PHOTON-PHOTON SCATTERING. V. N. Oraevskiĭ (Novosibirsk State Univ., U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1049-50(Oct. 1960). (In Russian)

The effective cross section for photon-photon scattering due to the existence of a meson decaying into two photons is estimated. (auth)

9733 ON THE DIAMAGNETISM OF A SYSTEM OF INTERACTING PARTICLES. I. G. Kaplan (Inst. of Chemical Physics, the Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1053-5(Oct. 1960). (In Russian)

It is shown that with an accuracy to terms of the order of h^2 the diamagnetic susceptibility of interacting particles is independent of the interaction. (auth)

9734 ENERGY FLUCTUATIONS IN THE INTERACTION BETWEEN HIGH ENERGY PARTICLES. N. M. Gerasimova (Lebedev Inst. of Physics, the Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1087-90(Oct. 1960). (In Russian)

Fluctuations of the energy transferred in an elementary act to a particular type of particle are considered on the basis of the hydrodynamical theory of multiple particle production. (auth)

9735 EFFECT OF WEAK INTERACTION ON THE ELECTROMAGNETIC PROPERTIES OF PARTICLES. Ya. B. Zel'dovich and A. M. Perelomov. Zhur. Eksptl'. i Teoret Fiz., 39: 1115-25(Oct. 1960). (In Russian)

The contribution of weak particle interaction to electromagnetic interaction was considered. In some cases the order of this contribution in the weak coupling constant may be different in the direct four-fermion interaction theory and in the intermediate vector boson theory. The corrections to the magnetic moment and nonconserving parity anapole interaction between the particles and the electromagnetic field were estimated. Expressions for scattering of a neutrino in the nuclear Coulomb field are presented. The polarization of recoil protons during the scattering of electrons was considered. The possibility of the existence of weak neutral currents and their effect on the scattering of electrons on protons and on the atomic effects are discussed. (auth)

9736 ON THE ROLE OF THE NONPHYSICAL REGION IN DISPERSION RELATIONS FOR π-MESON PHOTOPRODUCTION. A. M. Baldin (Lebedev Inst. of Physics, Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1151-3(Oct. 1960). (In Russian)

The initial postulations of G. F. Chew, et al., (Phys. Rev. 106: 1345(1957)), based on π-meson photoproduction at threshold, were correlated with experimental photoproduction dispersions and the discrepancies are indicated. It is suggested that evaluations of dispersion integrals may show even larger error in the nonphysical amplitude region differentiated by partial waves. In spite of the previously proved feasibility of analytical amplitude expansion, the problem of fast convergence in the Legendre series at $\cos\theta \gg 1$ still remains open. An analysis, made without consideration for the G. F. Chew equations, showed that the discrepancies with experiments take place only at angles and energies in which the nonphysical region does not exceed $\Delta\omega \sim 0.1$. A good agreement with experimental values is found at angles and energies in which the nonphysical region disappears ($k\omega - kq\cos\theta = k_{thresh.}$, where $\underline{k}$ is the photon energy. As an example, the cross section $d\sigma/d\Omega$ of $\gamma + p \rightarrow p + \pi^0$ with $\cos\theta = 1/\sqrt{3}$ is studied. The magnitude $d\sigma/d\Omega$ at $\cos\theta = 1/\sqrt{3}$ is in the region $k\omega - kq\cos\theta = k_{thresh.}$, with the nonphysical region disappearing at $q^2 \rightarrow 0$. Further analysis of the role of the nonphysical region will be published. (R.V.J.)

9737 ON THE TOTAL CROSS SECTIONS OF π-p SCATTERING AT HIGH ENERGIES. Yu. M. Lomsadze, V. I. Lend'el, and B. M. Ernst (Uzhzordsk State Univ., U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1154-5(Oct. 1960). (In Russian)

Considering the asymptotic nature of the dispersion relations for N-N scattering (for π-p scattering the results are identical) and assuming that $\sigma_+(\omega)$ and $\sigma_-(\omega)$ at $\omega \rightarrow \infty$ converge toward the constants $\sigma_+(\infty)$ and $\sigma_-(\infty)$, I. Ya. Pomeranchuk (Zhur. Eksptl'. i Teoret Fiz., 34: 724(1928)), found that $\sigma_+(\infty) = \sigma_-(\infty)$. This equality indicates that with $\omega \rightarrow \infty$ the difference $\sigma_+(\infty) - \sigma_-(\infty)$ should diminish as $1/\ln\omega$. The suggested concept is confirmed by an analysis of dispersion relations for π^+-p forward scattering (for N-N scattering the results are similar). (R.V.J.)

9738 ON SETTING UP EXPERIMENTS BY MEANS OF NEUTRINO BEAMS OF MESON ORIGIN. B. Pontecorvo (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1166-8(Oct. 1960). (In Russian)

The feasibility of using high energy neutrino beams emitted by mesons to acquire data on weak interactions has been widely discussed in published literature. It is shown that form factors related to the presence of strongly interacting particles stop the increase of the cross section of $\bar{\nu} + p \rightarrow e^+ + n$ reactions at neutrino energies of ~1 Bev. The presence of intermediate mesons (bosons) in weak interactions presents a special problem in experiments with high-energy neutrino beams ($\gtrsim$1 Bev). The intermediate boson, with about nucleon mass, has already been found in $\nu + Z \rightarrow B + Z + \binom{\mu}{e}$- type reactions with cross sections exceeding the characteristic neutrino-induced reaction cross section for strong local interactions. To verify the identity of neutrino (ν_μ), emitted in π-μ decay and neutrino emitted in β decay (ν_e), the author previously suggested using relatively low energy ν_μ beams emitted by localized μ^+ mesons. Additional considerations on neutrino with intermediate energy (< 300 Mev) are offered for resolving certain aspects of neutrino physics. These considerations should be useful in planning experiments with neutrino beams and in planning accelerators for the experiments. The identity of ν_e and ν_μ can be determined by measuring the cross section of $\nu_\mu + C^{12} \rightarrow e^- + N^{12}$. The energy of electrons emitted by the incoming monoenergetic ν_μ is known, the time of electron emission should coincide with the time of neutrino absorption and delayed positrons of N^{12} decay can be recorded. Such experiment can be carried out with a large propane bubble chamber using electronic particle recording. Calculations from the method can be compared to the results from the experiments. (R.V.J.)

9739 A STUDY OF ASYMMETRY IN THE DECAY OF NEGATIVE μ-MESONS IN A NUCLEAR EMULSION. A. O. Vaĭsenberg, E. D. Kolganova, and V. A. Smirnitskiĭ. Zhur. Eksptl'. i Teoret. Fiz., 39: 1198-1200(Nov. 1960). (In Russian)

The spatial asymmetry of electrons from the $\mu^- \rightarrow e^-$ decay in emulsions was studied in 11 k gauss zero fields. It is shown that for a total number of decay events, $\sim 10^4$, no asymmetry can be observed in either of the cases. (auth)

9740 FREON BUBBLE CHAMBER OBSERVATIONS ON THE ASYMMETRY IN THE DECAY OF Λ^0-HYPERONS PRODUCED BY 2.8 BeV/c π^--MESONS. V. V. Barmin, Yu. S. Krestnikov, I. I. Pershin, V. P. Rumyantseva, Ya. Ya. Shalamov, and V. A. Shebanov. Zhur. Eksptl'. i Teoret. Fiz., 39: 1229-31(Nov. 1960). (In Russian)

The asymmetry in the decay of Λ^0-hyperons with respect to the plane of creation was studied for Λ^0-particles created by 2.8-Bev/c π^--mesons on carbon, chlorine, and fluorine nuclei in a freon bubble chamber. The measured asymmetry coefficient is $\alpha\overline{P} = -0.30 \pm 0.15$. (auth)

9741 PRODUCTION OF π^0-MESONS IN COLLISIONS BETWEEN 2.8 BeV/c π^--MESONS AND PROTONS. Ya. Ya. Shalamov and V. A. Shebanov. Zhur. Eksptl'. i Teoret. Fiz., 39: 1232-6(Nov. 1960). (In Russian)

The production of π^0-mesons in the reactions $\pi^- + p \rightarrow m\pi^0 + n$(m = 1, 2, 3) was studied at $P_{\pi^-} = 2.8$ Bev/c in a 17-liter bubble chamber filled with a propane-xenon mixture or freon-12–freon-13 mixture. The cross section on hy-

drogen was determined by a difference method and found to equal (2.2 ± 0.3) mb. The mean number of γ-quanta per interaction is 4.0 ± 0.4. The angular distribution of the γ-quanta in the center-of-mass system is anisotropic and possesses a sharp peak in the forward direction. The small cross section for exchange scattering, $\sigma(\pi^- + p \rightarrow \pi^0 + n) = 0.20 \pm 0.25$ mb indicates that for the given π^--meson energy the partial interaction cross sections with isotopic spins $3/2$ and $1/2$ are equal. The cross sections for processes involving the formation of two or three π^0-mesons are estimated by analyzing the distribution of the events with respect to number of γ-quanta. (auth)

9742 PRODUCTION OF CHARGED HYPERONS BY 9 BeV PROTONS INTERACTING WITH PHOTOGRAPHIC EMULSION NUCLEI. L. P. Dzhanelidze, D. K. Kopylova, Yu. B. Korolevich, N. I. Kostanashvili, K. V. Mandritskaya, N. I. Petukhova, M. I. Podgoretskiĭ, D. Tuvdendorzh, O. A. Shakhulashvili, and Ching P'u-ying (Chzhen Pu-in) (Joint Inst. for Nuclear Research, Inst. of Physics, Academy of Sciences, Georgian SSR, Tblissi State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 39: 1237-41(Nov. 1960). (In Russian)

The angular distribution of $\pi^\pm$-mesons from decaying $\Sigma^\pm$-hyperons produced in the interaction between 9-Bev protons and photographic emulsion nuclei was studied. The charge composition of the hyperons is estimated. The cross section for production of charged hyperons on the emulsion nuclei is estimated. (auth)

9743 THEORY OF THE MAGNETIC PROPERTIES OF A NONIDEAL FERMI GAS AT LOW TEMPERATURES. I. A. Akhiezer and S. V. Peletminskiĭ (Inst. of Physics and Technology, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1308-16(Nov. 1960). (In Russian)

The effect of interaction between particles on the oscillations of the Fermi gas magnetic moment is studied by quantum field theory methods. The forces acting between the particles are assumed to be of the short range type and the calculations are performed in the gas approximation. The change in the period and amplitude of the oscillations of the magnetic moment due to interaction between the particles is determined. At not too low temperatures the oscillation amplitude contains a factor which decreases exponentially with decrease of the magnetic field. (auth)

9744 ELECTRON SCATTERING IN THE THOMAS–FERMI MODEL. T. Titts (Lodz Univ. Poland). Zhur. Eksptl'. i Teoret. Fiz., 39: 1347-8(Nov. 1960). (In Russian)

The differential cross section for scattering of electrons by atoms is calculated in the Thomas-Fermi approximation with the Latter potential. Results of numerical integration are presented for neon, silicon, and sulfur. The results are compared with those obtained by the Hartree method. (auth)

9745 A RESONANCE MODEL FOR THE REACTIONS $N + \pi \rightarrow N + \pi + \pi$ AND $\gamma + N \rightarrow N + \pi + \pi$. V. V. Anisovich (Inst. of Physics and Technology, Academy of Sciences, Ukrainian SSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1357-62 (Nov. 1960). (In Russian)

The $N + \pi \rightarrow N + \pi + \pi$ reaction for 300- to 550-Mev incident mesons and $\gamma + N \rightarrow N + \pi + \pi$ reaction for 450- to 700-Mev γ-quanta are studied phenomenologically. It is shown that the simple model in which it is assumed that the production of a meson in meson-nucleon collisions mainly proceeds via the transition $D_{3/2} \rightarrow P_{1/2}\, s_{1/2}$ satisfies all available experimental data. (auth)

9746 ON THE ANISOTROPY IN THE PROPAGATION OF LONGITUDINAL ELECTROACOUSTIC OSCILLATIONS IN A DRIFTING PLASMA. V. A. Liperovskiĭ (Moscow Inst. of Power Engineering, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 39: 1363-66(Nov. 1960). (In Russian)

The anisotropy in the propagation of low-frequency electroacoustic oscillations in a low-pressure gas discharge plasma observed experimentally is explained theoretically within the framework of the hydrodynamic approximation by taking into account collisions between the charged particles and neutral atoms. From the dispersion equation thus derived it follows that in the one-dimensional case oscillations of a given frequency will move under certain conditions from the cathode to anode with an increasing amplitude and from the anode to cathode with a decreasing amplitude. The anisotropy is mainly due to the combined action of collisions between the charged particles and atoms and the constant drift velocity. In the presence of boundaries the anisotropy is enhanced. (auth)

9747 A SCHEME OF WEAK INTERACTIONS WITH NEUTRAL CURRENTS. V. N. Baĭer and I. B. Khriplovich. Zhur. Eksptl'. i Teoret. Fiz., 39: 1374-80(Nov. 1960). (In Russian)

The cross sections for scattering and annihilation in the collision of like particles due to weak interactions are calculated. The degree of longitudinal polarization in nucleon-nucleon scattering is estimated. Effects caused by weak interactions between the electrons in the medium are considered. (auth)

9748 ACCOUNT OF THE NUCLEAR COULOMB FIELD IN PROCESSES INVOLVING THE INTERACTION BETWEEN ELECTRONS AND AN ELECTROMAGNETIC FIELD. V. G. Gorshkov (Leningrad Inst. of Physics and Technology, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1411-21(Nov. 1960). (In Russian)

Expressions for the matrix elements of the interaction between electrons and the electromagnetic field near the nucleus are derived which are convenient for practical calculations. The Coulomb field is taken into account with an accuracy to terms proportional to $(\alpha Z)^2$. (auth)

9749 DISPERSION RELATIONS IN NONRELATIVISTIC SCATTERING THEORY IN WHICH ACCOUNT IS MADE FOR SPIN-ORBIT INTERACTION. V. S. Buslaev (Leningrad State Univ., USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1422-6(Nov. 1960). (In Russian)

Dispersion relations for scattering of spin-$1/2$ particles on a potential containing the spin-orbit interaction are derived in nonrelativistic theory. The behavior of the total hamiltonian of Green's function is investigated at high complex energies. (auth)

9750 ANOMALOUS MAGNETIC MOMENTS OF THE MUON AND ELECTRON. V. B. Berestetskiĭ. Zhur. Eksptl'. i Teoret. Fiz., 39: 1427-9(Nov. 1960). (In Russian)

The dispersion relations and unitarity conditions yield a simple method for calculation of radiative corrections to quantum electrodynamics. A correction to the magnetic moment is calculated by taking into account the cut-off at high momenta. (auth)

9751 SEMI-ANALYTICAL SOLUTION OF EQUATIONS OF THE CHEW–MANDELSTAM TYPE. Yu. A. Simonov and K. A. Ter-Martirosyan. Zhur. Eksptl'. i Teoret. Fiz., 39: 1442-9(Nov. 1960). (In Russian)

A simple method for solving equations of the Chew-Mandelstam type is proposed which rapidly yields an approximate solution. The method is employed to solve the Chew-Mandelstam equations for the interaction between neutral and charged π-mesons. The first approximation results for charged π-mesons are compared with the numerical calculations of Chew, Mandelstam, and Noyes. (auth)

9752 SCATTERING THEORY FOR A THREE-PARTICLE SYSTEM. L. D. Faddeev (Inst. of Mathematics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1457-67(Nov. 1960). (In Russian)

It is shown that the eigenfunctions of the hamiltonian for a three-particle system with pair interaction can be represented in a natural fashion as the sum of three terms for each of which a linked equation set exists. This set can be written down with help of the solutions of the pair problems and can be unequally solved in contrast to equations of the Lippmann–Schwinger type. In the limit of zero range the well-known Skornyakov–Ter-Martirosyan equations are obtained. (auth)

9753 ON THE MATRIX OF NUCLEON SCATTERING ON A SPIN-1 TARGET. P. Vinternits (Leningrad State Univ., U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 39: 1476 (Nov. 1960). (In Russian)

An attempt is made to correct the general appearance of the G. M. Budyanskii (Zhur. Eksptl'. i Teoret. Fiz. 33, 889(1957)) scattering matrix for particles with spin-$\frac{1}{2}$ on targets with spin-1. (R.V.J.)

9754 OBSERVATIONS OF POSITRON REACTIONS IN AQUEOUS SOLUTIONS. V. I. Gol'danskiĭ, O. A. Karpukhin, and G. G. Petrov (Lebedev Inst. of Physics and Inst. of Chemical Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1477-8(Nov. 1960). (In Russian)

A series of experiments was carried out on the rate of 3-γ positron annihilation in aqueous solutions in order to demonstrate the effects of various substances on annihilation and to show a correlation with oxidation-reduction. The rates of 3-γ annihilation are compared for pure water and water with various admixtures. (R.V.J.)

9755 DIPOLE MOMENT OF UNSTABLE ELEMENTARY PARTICLES. Ya. B. Zel'dovich. Zhur. Eksptl'. i Teoret. Fiz., 39: 1483-5(Nov. 1960). (In Russian)

An unstable particle is characterized by an exponential amplitude state and is surrounded by dispersed waves of scattered decay products. A change of sign converts the unstable particle into a state with an exponential amplitude surrounded by colliding decay products. Hence, the previously postulated theory that elementary particles do not possess dipole moments does not hold for unstable particles. A relation between instability and dipole moment is analyzed using a neutral particle A^0 of spin-$\frac{1}{2}$. A correlation of parity disturbance, with the conservation of T-invariance in the hamiltonian, with the instability of the particle indicates the appearance of a dipole moment, i.e., it indicates an apparent disturbance in T-invariance. In principle it is confirmed that certain properties assigned to stable particles do not always hold for unstable particles. (R.V.J.)

9756 ON PION-PION RESONANCE IN p-STATE. Ho Tso-hsiu (Khe Tszo-syu) and Chou Kuang-chao (Chzhou Guan-chzhao) (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 39: 1485-6(Nov. 1960). (In Russian)

Processes $\pi^\pm + He^4 \rightarrow He^4 + \pi^\pm + \pi^0$; $\pi^\pm + d \rightarrow d + \pi^\pm + \pi^0$; $p + p \rightarrow d + \pi^+ + \pi^0$ are suggested for investigating p-state π-π resonance. All the processes possess isospin I = 1 in the initial state, consequently, the pion pair has isospin I = 1 in the final state and is in a state with odd orbital moment. At low energies the pions are in the ground p-state. Assuming that the isobar with mass of 435 Mev and semi-width 10 Mev is in the p-state, then the pion pair is produced in isobar decay, together with the He^4 or d and a sharp maximum is anticipated in the He^4 (or d) spectra. An analysis was made of the maxima in the processes. It is shown that in the absence of the p-isobar state the He^4(d) spectrum changes smoothly and is determined by a statistical phase multiplier. Hence, the measurements of spectra for the reactions confirm the presence of p-resonance in pion-pion systems. It is also observed that $d + d \rightarrow He^4 + \pi^0 + \pi^+ + \pi^-$ can be utilized in studies of isobar structure in pion-pion systems. (R.V.J.)

9757 INVESTIGATION OF μ^+-MESON DEPOLARIZATION IN A NUCLEAR EMULSION. Yu. M. Ivanov and A. I. Fesenko (Moscow Inst. of Engineering Physics). Zhur. Eksptl'. i Teoret. Fiz., 39: 1492-6(Dec. 1960). (In Russian)

The influence of the relative content of AgBr in a nuclear emulsion on the magnitude of the asymmetry coefficient for $\mu^+ - e^+$-decay was studied experimentally. Separate values were obtained for the μ^+ meson depolarization AgBr and the gelatin. (auth)

9758 PRODUCTION OF NUCLEAR FRAGMENTS IN NUCLEAR EMULSIONS BY 80 MEV π^+-MESONS. A. S. Assovskaya and N. S. Ivanova (Radium Inst., Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1511-16(Dec. 1960). (In Russian)

The production of multi-charged particles by comparatively low energy (80 Mev) π^+ mesons was investigated with nuclear emulsions. An analysis of the charge, energy, and angular distributions of the fragments and a comparison of the experimental data with the results of calculations indicated that for such incident meson energies the fragments are produced only by fast protons formed within the nucleus as a result of absorption of the π^+ meson by a nucleon pair (n,p). The experimental data did not contradict the possibility that the fragments are ejected by these protons. (auth)

9759 LOW ENERGY $\pi\pi$-SCATTERING INTEGRAL EQUATIONS. Ting-chang Hsien, Tso-hsiu Ho, and W. Zöllner (Joint Inst. for Nuclear Research, Dubna, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1668-76(Dec 1960). (In Russian)

A critical analysis of the Chew-Mandelstam equations for π-π scattering is presented. With help of the dispersion relations for fixed momentum transfer and the unitarity condition, new equations were derived which differ from the Chew-Mandelstam equations in respect to the contribution of the nonphysical region. (auth)

9760 CALCULATION OF TRANSITION EFFECTS AT VARIOUS DISTANCES FROM THE ELECTRON-PHOTON SHOWER AXIS. O. I. Dovzhenko (Lebedev Inst. of Physics, Moscow). Zhur. Eksptl'. i Teoret. Fiz., 39: 1686-92(Dec. 1960). (In Russian)

A method for calculating transition effects in thin layers of matter (t < 1 rad length) was developed for radiation consisting of electrons and photons with an arbitrary spectrum. The results obtained were employed to calculate air-ionization chamber wall transition effects at various distances r from the electron-photon shower axis for s = 1 and an infinite primary energy. Electron and photon energy spectra corresponding to various values of r were derived by the method of moments. (auth)

9761 RESONANCE EFFECTS OF RADIATION IN A LAMINAR MEDIUM. M. L. Ter-Mikaelyan and A. D. Gazazyan (Erivan State Univ. and Inst. of Physics, Academy of Sciences, Armenian SSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1693-8(Dec. 1960). (In Russian)

Resonance radiation was studied in a periodic medium which is most convenient for experimentation, that is, in a

laminar medium. Laminar media consisting of two arbitrary plates with different or equal thicknesses were considered. Formulas for the spectral distribution and for the total number of radiated quanta were derived. The frequency ranges (for each harmonic r = 1, 2, 3, ...) and the energy threshold of the radiation were determined. (auth)

9762 ON A PARTICULAR CASE OF PERIPHERAL INTERACTIONS BETWEEN HIGH ENERGY NUCLEONS. P. A. Usik and V. I. Rus'kin (Inst. of Nuclear Physics, Academy of Sciences, Kazakh SSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1718-20(Dec. 1960). (In Russian)

Peripheral collisions of two fast nucleons occurring as a π-π interaction were considered. The results of the calculations are compared with the experimental data. (auth)

9763 INTERNAL BREMSSTRAHLUNG AND ELECTROMAGNETIC CORRECTIONS TO μ-e-DECAY. V. P. Kuznetsov (Moscow Inst. of Physics and Tech.). Zhur. Eksptl'. i Teoret. Fiz., 39: 1721-6(Dec. 1960). (In Russian)

Electromagnetic corrections to the electron polarization, the electron and μ meson polarization correlation in μ-e-decay, and the polarization and angular distribution of γ quanta in the internal bremsstrahlung were derived. Electromagnetic corrections to the spectrum, angular distribution, and electron polarization in μ-e-decay were computed in the low-energy region. (auth)

9764 ON THE DETERMINATION OF THE SIGN OF THE MASS DIFFERENCE OF K_1^0-AND K_2^0-MESONS. S. G. Matinyan (Inst. of Physics, Academy of Sciences, Georgian SSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1747-55(Dec. 1960). (In Russian)

The experiment proposed by Kobzarev and Okun for determining the sign of the mass difference Δm of K_1^0 and K_2^0 mesons is discussed from the viewpoint of taking into account the finite thickness of the plates through which the K_2^0 meson beam passes. A modification of the experiment is suggested which should increase the amount of K_1^0 mesons leaving the plates. Other ways of determining the sign of Δm are also considered. (auth)

9765 FORM FACTOR FOR $K_{\mu 3}$- AND K_{e3}-DECAY. Ya B. Zel'dovich. Zhur. Eksptl'. i Teoret. Fiz., 39: 1766-9(Dec. 1960). (In Russian)

A hypothesis is proposed according to which the K and π meson 4-velocities symmetrically enter the expression of the matrix element for interaction between K and π mesons with the lepton current (on which $K_{\mu 3}$ and K_{e3} decay depends). (auth)

9766 APPLICATION OF MANDELSTAM'S METHOD TO A COMPUTATION OF THE SCATTERING AMPLITUDE WITH ANOMALOUS SINGULARITIES. V. A. Franke (Leningrad Inst. of Personnel Protection). Zhur. Eksptl'. i Teoret. Fiz., 39: 1818-28(Dec. 1960). (In Russian)

The method of calculation of the scattering amplitude proposed by Mandelstam was extended to the case of two interacting neutral scalar fields describing particles with masses m and M obeying the conditions $m\sqrt{3} > M > m\sqrt{2}$. Anomalous singularities of the amplitude, which occur when the indicated relation between the masses is valid, were taken into account. Conditions are indicated when the method of the present work can be extended to more complicated cases. (auth)

9767 ELECTROMAGNETIC RADIATION EMITTED IN THE COLLISIONS BETWEEN CHARGED PARTICLES WITH CLOSE SPECIFIC CHARGED e/m VALUES. E. I. Malkov and I. M. Shmushkevich (Leningrad Inst. of Physics and Tech.). Zhur. Eksptl'. i Teoret. Fiz., 39: 1837-46(Dec. 1960). (In Russian)

The differential cross section for bremsstrahlung emitted in the collision of charged particles with equal or almost equal values of e/m was calculated in the case when quadrupole radiation was predominant. Formulas for the angular and energy distributions and radiation polarization were derived by taking into account quadrupole and dipole terms and their interference. The calculations were performed by a classical method which is valid in the low frequency range and at sufficiently small energies of the colliding particles. (auth)

9768 SOME ENERGY RELATIONS DEDUCED BY TAKING INTO ACCOUNT PARITY NONCONSERVATION IN μ-e-DECAY. V. S. Berezinskiĭ and G. T. Zatsepin (Lebedev Inst. of Physics, Moscow). Zhur. Eksptl'. i Teoret. Fiz., 39: 1847-9(Dec. 1960). (In Russian)

The fraction of energy transferred to electrons in $\mu \rightarrow e$ or $\pi \rightarrow \mu \rightarrow e$ decay was computed, taking into account parity nonconservation in $\mu \rightarrow e$ decay. (auth)

9769 CHARGED MESON PRODUCTION BY 245 MEV π^- MESONS IN HYDROGEN. Yu. A. Batusov, S. A. Bunyatov, V. M. Sidorov, and V. A. Yarba (Joint Inst. for Nuclear Research, Dubna, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1850-2(Dec. 1960). (In Russian)

Preliminary data are given from studies of $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ reactions at a primary meson energy of 245 ± 15 Mev. Thirty-two events were recorded and the cross section of the reaction was found to be 0.10 ± 0.04 mb. Experimental data for the total cross sections are plotted as functions of the incoming meson energy; near the threshold (172 Mev) the cross section rapidly diminishes. The comparison of pulse and angular distributions of secondary particles (center of inertia system at a π-meson energy of 245 Mev) with published data for π mesons at 290 Mev shows very small variations. Further development of the data is planned in order to find the amplitudes of recharge at zero energies. (R.V.J.)

9770 ON THE PROBLEM OF NON-CONSERVATION OF PARITY IN STRONG INTERACTIONS WITH STRANGE PARTICLES. Kang-chang Wang, Ts'u-tsêng Wang, V. I. Vekslev, I. Vrana, Ta-ts'ao Ting, V. G. Ivanov, Ni In Kim, E. N. Kladnitskaya, A. A. Kuznetsov, Din Ty Nguen, A. V. Nikitin, M. I. Solov'ev, T. Khofmolk, and Ling-yang Ch'êng (Joint Inst. for Nuclear Research, Dubna, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1854-6(Dec. 1960). (In Russian)

The angular asymmetry in Λ^0 decay from π^--p interactions at 7 to 8 Bev was analyzed in order to verify a postulation stating that the appearance of longitudinal polarization in Λ^0, produced by nuclear interactions, attests to the nonconservation of parity in strong interactions. Eighty-four Λ^0 and 9 K° decays were found in 14,000 pictures of 6.8-Bev incident π^- mesons, and 91 Λ^0 and 24 Λ^0 on K° decay were found in 20,000 pictures of 8-Bev incident π^- mesons. The admixture of Λ^0 formed by quasi-free protons was 20%; a very small number was produced by Σ^0 decay. The 208 events were divided into four groups and Λ^0 asymmetry was plotted. The results indicate no asymmetry within the limits of statistical error, neither right to left nor up and down. However, asymmetry in the forward-backward direction may be of great importance. (R.V.J.)

9771 PROCEEDINGS OF THE 1960 ANNUAL INTERNATIONAL CONFERENCE ON HIGH ENERGY PHYSICS AT ROCHESTER, THE UNIVERSITY OF ROCHESTER, ROCHESTER, N. Y., AUGUST 25-SEPTEMBER 1, 1960. E. C. G. Sudarshan, J. H. Tinlot, and A. C. Melissinos, eds. New York, Interscience Publishers, Inc., 1960. 910p. $13.50.

Two hundred and twelve papers are included. One hundred and sixty-eight of the papers are covered by separate

abstracts. Thirty-one papers were abstracted previously in Nuclear Science Abstracts. (M.C.G.)

9772 PHOTOPRODUCTION OF NEUTRAL PIONS AND POLARIZATION OF THE RECOIL PROTONS. G. Salvini (Frascati Labs., Rome, Italy). p.3-13 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A measurement was made of the differential cross section for single meson (π^0) photoproduction on hydrogen. The peak of the differential cross section was found to be at 56° c.m.s. angle and at an energy of about 700 Mev. The polarization of the recoil proton was measured by both counter and bubble chamber techniques at 500 to 900 Mev. (M.C.G.)

9773 A NUCLEAR EMULSION EXPERIMENT TO MEASURE THE POLARIZATION OF THE RECOIL PROTON IN THE PHOTOPRODUCTION OF NEUTRAL PIONS IN HYDROGEN. J. O. Maloy (California Inst. of Tech., Pasadena), J. I. Friedman, H. Kendall, A. Manfredini, V. Z. Peterson, and G. A. Salandin. p.14-17 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An experiment was begun to measure the polarization of recoil protons produced in the high-energy photoproduction of neutral pions from hydrogen, using nuclear emulsions as a scatter-detector. Preliminary results were obtained at photon energies of 585 and 660 Mev. The range of the scattered tracks was measured in order to determine the ratio of inelastic to elastic scattering. It was found that the magnitude of the polarization, obtained under the assumption that the second resonance has even parity and that the polarization arises by interference with an s-wave background, must be considerably smaller than that given by Stoppini and Pelligrini. (M.C.G.)

9774 PHOTOPRODUCTION OF POSITIVE PIONS FROM HYDROGEN. R. L. Walker (California Inst. of Tech., Pasadena). p.17-21 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Measurements at small angles were made of meson (π^+) photoproduction from hydrogen. The data obtained at various energies from 700 to 1100 Mev are given. The cross section rose steeply as the angle approached 0° at all energies investigated. The rapid variations of cross section with angle in the small angle region were assumed to arise from the photoelectric term and interference effects. The cross sections at 0 and 180° had relatively simple expressions in the partial wave analysis, and were not complicated by the photoelectric term. (M.C.G.)

9775 A MEASUREMENT OF THE PRESENCE OF THE RETARDATION TERM IN PION PHOTOPRODUCTION USING POLARIZED X-RAYS OF 342 AND 373 MeV. R. C. Smith and R. F. Mozley (Stanford Univ., Calif.). p.22-3 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Measurements of meson (π^+) photoproduction were made using polarized x rays in order to show the desirability of a retardation term in fitting the measured angular distributions. A relation was derived in which $PA = (R - 1/R + 1)(\sigma \text{ unpolarized}/\sin 2\theta)$ where P is polarization, σ is cross section, θ is angle of meson production, and R is the ratio of yields of positive and negative polarization. (M.C.G.)

9776 π^+ PHOTOPRODUCTION FROM HYDROGEN NEAR THRESHOLD. J. G. Rutherglen, J. Walker, D. Miller, and J. M. Patterson (Glasgow Univ., Scotland). p.23-5 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The meson (π^+) photoproduction cross sections in hydrogen were measured in the energy range from 160 to 200 Mev in order to obtain information on the threshold rise of the coefficient, a_3^+. The results supported the shape of the theoretical curve in this region. (M.C.G.)

9777 ANALYSIS OF PHOTOPION PRODUCTION NEAR THRESHOLD. A. M. Baldin (Lebedev Physical Institute, Moscow, USSR). p.26 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The angular distributions of mesons (π^+) were measured near threshold for the reaction $\gamma + p \rightarrow n + \pi^+$. The experimental results were compared with a dispersion relation approach. (M.C.G.)

9778 AN EXPERIMENT TO DETERMINE THE π^0 LIFETIME. A. V. Tollestrup, S. Berman, R. Gomez, and H. Ruderman (California Inst. of Tech., Pasadena). p.27-30 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An attempt was made to determine the lifetime of the meson (π^0) by observation of the photoproduction process in the Coulomb field. The cross sections were measured for a lead target. The lifetime was not determined from the data. However, calculations indicate that, if all the counts at 0° can be attributed to the lifetime effect, the lifetime is $\geq 5 \times 10^{-17}$ sec. (M.C.G.)

9779 THE LIFETIME OF THE NEUTRAL PION. R. G. Glasser, N. Seeman, and B. Stiller (Naval Research Lab., Washington, D. C.). p.30-1 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Preliminary results gave a lifetime of $2.3 \pm 0.8 \times 10^{-16}$ sec for the neutral pion. Mesons (K^+) were stopped in an emulsion and the emulsion scanned for $K_{\pi 2}$ decays accompanied by a Dalitz pair. The weighted average of the events gave 0.122 ± 0.045 for the mean decay distance. This led to the lifetime value given. (M.C.G.)

9780 RESULTS IN PION PROTON SCATTERING NEAR THE HIGHER RESONANCES. P. Falk-Vairant and G. Valladas (Centre d'Études Nucléaires, Saclay, France). p.38-45 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The available information on the total cross sections for pion-proton scattering in the energy region from 400 Mev to 1.5 Bev is presented. Cross sections for elastic scattering, inelastic scattering, and charge exchange are also given. (M.C.G.)

9781 PRODUCTION OF CHARGED PIONS IN NEUTRON-PROTON COLLISIONS AT 590 MeV. V. P. Dzhelepov, V. S. Kiselev, K. O. Oganesyan, and V. B. Flyagin (Joint Inst. of Nuclear Research, Dubna, USSR). p.46-8 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of

Rochester, Rochester, N. Y., August 25–September 1, 1960."

The production of mesons was studied in the reactions $n + p \rightarrow \pi^+ + n + n$ and $n + p \rightarrow \pi^- + p + p$ at 590 ± 10 Mev. Pion energy spectra were determined for angles of 16, 31, 60, 90, and 123°. For all angles and mesons of both signs, the spectra had a maximum at about 75 Mev. Angular distributions were also determined. The symmetry of the distributions around 90° indicated that at the energy under study the contribution of the term determined by interference between transitions by the corresponding partial cross sections is small. (M.C.G.)

9782 CHECK OF THE CHARGE INDEPENDENCE PRINCIPLE IN THE REACTION $d + d \rightarrow \pi^0 + He^4$ AT 400 MeV DEUTERON ENERGY. Yu. K. Akimov, O. V. Savchenko, and L. M. Soroko (Joint Inst. for Nuclear Research, Dubna, USSR). p.49-51 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The charge independence of nuclear forces was tested by establishing the degree of prohibition caused by isotopic spin conservation in the reaction $d + d \rightarrow \pi^0 + He^4$ at 400 Mev. During 7 hr of deuteron bombardment of deuteron, not a single α particle was registered which might be produced in the reaction $d + d \rightarrow \pi^0 + He^4$. These data show that the cross section for the reaction is less than 2×10^{-32} cm^2. This cross section is comparable with that for $d + d \rightarrow \gamma + He^4$. If there was no prohibition of the reaction $d + d \rightarrow \pi^0 + He^4$, the cross sections of the two processes should differ by a factor of approximately 100. This indicates that the principle of charge independence of nuclear forces is strictly observed. (M.C.G.)

9783 EFFECTS OF F AND G WAVES ON THE PHASE-SHIFT ANALYSIS OF π^+-p SCATTERING AT 310 MeV. J. H. Foote, O. Chamberlain, E. H. Rogers, and H. M. Steiner (University of California, Berkeley). p.52-5 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The S, P, and D phase-shift analysis of π^+-p scattering data was extended to include F phase shifts. The presence of small F phase shifts considerably increased the errors in previous solutions and also caused certain solutions that were formerly poor fits to the data to become satisfactory. The effects of G waves on the analysis were investigated and it was found that if G waves were allowed, the available data could not adequately determine the phase shifts. (M.C.G.)

9784 EXPERIMENTAL DATA FOR DETERMINING THE PION-PION CROSS SECTION. J. A. Anderson, P. G. Burke, D. D. Carmony, and N. Schmitz (University of California, Berkeley). p.58-61 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The reaction $\pi^- + p \rightarrow \pi^- + p + \pi^0$ was studied. For each event the proton momentum and angle were measured. Experimental distributions $F(p^2, \omega^2)$ are given as functions of p^2, where p is the difference in proton momentum before and after the interaction and ω is the total energy of the two resulting pions. A method for extracting pion-pion cross section from these functions by an extrapolation procedure is discussed. The values obtained for the cross section depend on the kind of expression used for $F(p^2, \omega^2)$. (M.C.G.)

9785 π^--NEUTRON TOTAL CROSS SECTION AT 136 MeV. M. Derrick, J. Fetkovich, T. Fields, E. G. Pewitt, and G. B. Yodh (Carnegie Inst. of Tech., Pittsburgh, Penna.). p.61-3 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The π^--neutron cross section was determined using the extrapolation method devised by Chew and Low. A 142 ± 6-Mev meson (π^-) beam was directed on a deuterium bubble chamber. The elastic π^--d scatterings were separated from the inelastic events by means of angular correlations, range of the deuterons, and coplanarity. A value of 120 ± 10 mb was obtained for the neutron production cross section. (M.C.G.)

9786 (n–p) SCATTERING AT 190 MeV NEUTRON ENERGY. Yu. M. Kazarinov and Yu. N. Simonov (Joint Inst. for Nuclear Research, Dubna, USSR). p.66-9 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The differential cross sections of neutron scattering by protons at 190 Mev were measured in the widest angle width possible. The measured data were corrected for detection efficiency. The data obtained were in excellent agreement with the value of the coupling constant of meson (π)-nucleon interaction, $f^2 = 0.08$. (M.C.G.)

9787 PION INTERACTIONS IN HYDROGEN AT 1.10 BeV. E. Pickup, D. K. Robinson, and E. O. Salant (Brookhaven National Lab., Upton, N. Y.). p.72-3 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

About 2300 interactions produced by 1.10-Bev negative pions in a hydrogen bubble chamber were analyzed. Preliminary results are given for the inelastic processes $\pi^- + p \rightarrow \pi^+ + \pi^+ + n$ and $\pi^- + p \rightarrow \pi^- + \pi^0 + p$. A high momentum peak was found at about 450 Mev/c for both negative and positive pions. The angular distribution of the neutrons was predominantly backward. (M.C.G.)

9788 PRODUCTION OF CHARGED MESONS BY 245 MeV π^- MESONS ON HYDROGEN. Yu. A. Batusov, S. A. Bunyatov, V. M. Sidorov, and V. A. Yarba (Joint Inst. for Nuclear Research, Dubna, USSR). p.74-5 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Preliminary results of a study of the reaction $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ at a primary meson energy of 245 ± 15 Mev are given. Momentum and angular distributions were compared with data obtained at 290 Mev. (M.C.G.)

9789 PRODUCTION OF CHARGED MESONS BY 290 MeV π^--MESONS ON HYDROGEN. Yu. A. Batusov, S. A. Bunyatov, V. M. Sidorov, and V. A. Yarba (Joint Inst. for Nuclear Research, Dubna, USSR). p.76-8 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Momentum spectra and angular distributions were determined for the reaction $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ at 290 ± 15 Mev. Results were compared to calculations made according to the statistical theory and the isobar model. (M.C.G.)

9790 DETERMINATION OF THE CHARGE-EXCHANGE CROSS SECTION OF π-MESONS INTO π-MESONS FROM

THE ANALYSIS OF THE REACTION $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ AT 290 MeV. Yu. A. Batusov, S. A. Bunyatov, V. M. Sidorov, and V. A. Yarba (Joint Inst. for Nuclear Research, Dubna, USSR). p.79-82 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The reaction $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ was studied in order to test the validity of some of the theories about the amplitude and cross section of the charge exchange process. Data on π-π interaction cross sections and s-wave scattering lengths are given. (M.C.G.)

9791 INELASTIC (π^-,N)-INTERACTIONS AT THE ENERGY OF 7 BeV. V. Petrzilka (Karlova Univ., Prague, Czechoslovakia). p.82-91 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

New results obtained in π^--N interactions at 7 Bev are reported. Distribution of the interactions is given as a function of charged particles. The angular distributions, momentum spectra, and cross sections were determined. The results were analyzed from the point of view of the statistical theory, nucleon model, and other theoretical concepts. (M.C.G.)

9792 ELASTIC AND INELASTIC PROTON-NUCLEON INTERACTIONS AT HIGH ENERGIES. S. A. Azimov, B. P. Bannik, V. G. Grishin, et al. (Joint Inst. for Nuclear Research, Physical Inst. of the Academy of Sciences of the USSR). p.91-100 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Proton-proton elastic scattering was investigated at 2.8 and 8.5 Bev. A value of 8.74 ± 0.40 mb was obtained for the total cross section. Experimental and theoretical curves for angular distributions are given. A study was made of p-p and p-n interactions under such conditions that the measurements of the multiple scattering and the determination of the sign of fast particles was possible. The angular distributions of secondary protons from p-p interactions showed strong anisotropy. The angular distribution of mesons (π) from this interaction was also anisotropic, but it was considerably broader than that of protons. In p-n interactions, the angular distributions in the forward directions were greater than in the backward direction. Momentum distributions and angles of emission are also given. (M.C.G.)

9793 RECENT WORK ON NUCLEON-NUCLEON SCATTERING AT HARWELL. B. Rose (Atomic Energy Research Establishment, Harwell, Didcot, England). p.100-6 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Preliminary values were determined for the polarization in n-p scattering in the energy range from 22.5 to 110 Mev. Protons, at 143 Mev, were directed on to an aluminum target. Neutrons, produced at 45°, were collimated and then scattered by liquid hydrogen. The neutrons were polarized in the production process and the polarization determined by small angle Schwinger scattering from uranium. The measured polarization of the beam was approximately 20 to 30% from 20 to 120 Mev. Disagreement between experimental values for the depolarization parameter in p-p scattering is discussed. A phase-shift analysis was made of p-p interaction data at various energies using the old and new values for depolarization parameters. (M.C.G.)

9794 NUCLEON-NUCLEON SCATTERING AT HARVARD. R. Wilson (Harvard Univ., Cambridge, Mass.). p.107-11 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The values for σ, P, R, and D in p-p scattering at 140 Mev are discussed. The method used to keep the scattering in a horizontal plane is described. In order to determine the dependence of D on energy, measurements were also made at 98 Mev. Cross sections and polarization were determined for n-p reactions at 128 Mev. Preliminary measurements of D and R for p-n scattering were obtained by proton scattering from deuterium. Absorption measurements made of the p-p total cross section showed that earlier values were high by 6%. (M.C.G.)

9795 NUCLEON-NUCLEON SCATTERING EXPERIMENTS AT ROCHESTER. A. England, W. Gibson, K. Gotow, E. Heer, J. Tinlot, and R. Warner (Univ. of Rochester, N. Y.). p.111-15 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Investigations were made of p-p and p-n interactions at 210 Mev. In the p-p triple scattering experiments, the first scattering was from carbon, the second from liquid hydrogen, and the third from carbon. Values for the scattering parameters D, A, and R were obtained. Three acceptable phase-shift solutions were found from a 9-parameter search. Preliminary results for the p-n polarization at 210 Mev are given. (M.C.G.)

9796 CORRELATION OF THE NORMAL COMPONENTS OF POLARIZATION IN ELASTIC (pp)-SCATTERING FOR 90° (CMS) AT 650 MeV. V. P. Dzhelepov (Joint Inst. for Nuclear Research, Dubna, USSR). p.115-16 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The spin correlation coefficient, C_{nn}, was determined for p-p scattering at 650 Mev. Correlation asymmetry was found to be 0.27 ± 0.04, and a value of 0.93 ± 0.21 was obtained for the spin correlation coefficient. It was found that the contribution of the triplet p-p interaction to the cross section of elastic p-p scattering for 90° at 650 Mev is 96%. (M.C.G.)

9797 ENERGY DEPENDENCE OF p-p PHASE SHIFTS. H. P. Stapp, M. J. Moravcsik, and H. P. Noyes (University of California, Livermore and Berkeley). p.128-32 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A phase-shift analysis was begun for p-p scattering experiments at 10 to 382 Mev. Functional forms incorporating recently proved analytic properties of partial wave scattering amplitudes were used. Phase shifts are given as functions of energy. The best solution and the one-pion exchange contribution are given. Analyses were restricted to Gammel-Thaler type solutions. (M.C.G.)

9798 NUCLEON-NUCLEON PHASE PARAMETERS. G. Breit (Yale Univ., New Haven, Conn.). p.132-7 of "Proceedings of the 1960 Annual International Conference on

High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Improved accuracy of phase parameters was obtained in selected energy regions. The various gradient searches for p-p scattering gave essentially the same final fit even though the starting points were different. For n-p scattering, the various starting points did not give nearly as definite convergence of the T = 0 parameters to a final fit. Selected plots of phase parameters and fits to data are shown. (M.C.G.)

9799 PHASE-SHIFT ANALYSIS OF p-p SCATTERING AT 95, 150 AND 310 MeV. A. A. Tyapkin (Joint Inst. for Nuclear Research, Dubna, USSR). p.138-40 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A phase analysis of p-p scattering data was carried out for energies of 95, 150, and 310 Mev by means of a calculation method suggested by Gelfand. This method was specially adapted to the investigation of the shape near the minimum of the function x^2. Boundaries of region of solution and some solutions are given for each energy. (M.C.G.)

9800 TWO-NUCLEON POTENTIAL WITH FULL RECOIL AND THE DETERMINATION OF THE TYPE OF COUPLING BETWEEN THE PION AND THE NUCLEON. S. Machida (Rikkyo Univ., Tokyo, Japan). p.141-4 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The nonstatic one- and two-pion exchange potentials were calculated without making use of the expansion in the inverse mass of the nucleon. It was found that the concept of the local potential in the x-space is a very good approximation for the treatment of the nucleon-nucleon scattering up to 300 or 400 Mev. The two-pion-exchange potential was evaluated up to the fourth order of the coupling constant without using the expansion with respect to M^{-1}. (M.C.G.)

9801 POLARIZATION IN PROTON-PROTON AND PROTON-BERYLLIUM SCATTERING AT 1.7 GeV. L. van Rossum (Centre d'Études Nucléaires, Saclay, France). p.144-8 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Double scattering experiments were carried out to investigate proton-beryllium and proton-proton polarization at 1.7 Bev. The left-right asymmetry of the proton differential cross section in the second scattering was measured under various conditions. The angle of maximum polarization as a function of momentum and the maximum polarization as a function of energy were determined. (M.C.G.)

9802 RECENT EXPERIMENTS ON THE ANTINUCLEON-NUCLEON INTERACTION. W. A. Wenzel (University of California, Berkeley). p.151-9 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The energy dependence of cross sections was investigated for $\bar{p}$-p interactions. The value for total cross sections fell at high energies but was still almost twice as large as the corresponding nucleon-nucleon cross sections. The elastic cross section was about one-third of the total cross section. Angular distributions were measured at 1.0, 1.25, and 2.0 Bev. The $\bar{p}$-n cross sections were determined by subtraction of $\bar{p}$-d and $\bar{p}$-p measurements. Antineutrons were produced by the charge exchange of 940-Mev antiprotons. A value of 8 ± 1 mb was obtained for the charge-exchange cross section. The total, elastic, and charge-exchange cross sections for antiprotons on beryllium and carbon were measured. Pion multiplicity, momentum spectra, meson production, and pion-pion correlations were investigated in nucleon-antinucleon interactions. (M.C.G.)

9803 DOUBLE SCATTERING OF ANTIPROTONS IN HYDROGEN. J. Lannutti, G. Lynch, B. Maglic, M. L. Stevenson, and Nguyen-h-Xuong (Univ. of California, Berkeley). p.159-64 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The polarization of antiprotons in double elastic $\bar{p}$-p scattering in a hydrogen bubble chamber was investigated. Angular distributions were determined. In two experiments values of ±0.49 ± 0.08 and ±0.05 ± 0.19 were obtained for angles from 6 to 25 and 2 to 6°, respectively. For the magnetic moment, experimental results gave −1.9 ± 1.4 n.m. (M.C.G.)

9804 ANTIPROTON EXPERIMENTS IN A HYDROGEN BUBBLE CHAMBER. F. Solmitz (Univ. of California, Berkeley). p.164-72 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A search was made for π-π resonances in antiproton annihilation reactions at 1.65 Bev/c. The shape of the energy spectrum was determined for particles produced in the annihilations yielding two visible prongs. Annihilations into two or four charged pions were examined for evidence of heavy neutral particles. The missing-mass spectra of the events were plotted. Results did not indicate the presence of the particle, but did not entirely rule it out. A search was made for the reactions $\bar{p} + p \rightarrow \pi^+ + \pi^-$ and $\bar{p} + p \rightarrow K^+ + K^-$. In the approximately 13,000 two-prong events investigated, 15 appeared to fit the first reaction and 6 the second reaction. A comparison was made of high-energy antiproton annihilations and statistical model predictions. Values of 1.5 ± 0.4 and 1.1 ± 0.3 mb were obtained for the cross sections of the reactions $\bar{p} + p \rightarrow \bar{p} + p + \pi^0$ and $\bar{p} + p \rightarrow \bar{p} + n + \pi^+$. (M.C.G.)

9805 PION-PION INTERACTION AND ANTINUCLEON ANNIHILATION. G. Pinski (Univ. of Rochester, New York), E. C. G. Sudarshan, and K. T. Manhantappa. p.173-7 of "Proceedings of the 1960 Annual International Conference on High Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An examination was made of the role of pion-pion interactions in antinucleon annihilation. The pion-pion resonance in the T = 1 state was investigated. The probability distribution of the effective mass squared, M^2, of a pair of pions of known charge was calculated. The nonresonant case exhibited a broad distribution of M^2 for pions of both like and unlike charge. For the resonant case the distribution for like charges was still relatively broad, but unlike pion M^2 distribution was sharply peaked at a value of M slightly higher than 4. This model is particularly relevant for antinucleon annihilation. (M.C.G.)

9806 MEASUREMENT OF THE PANOFSKY RATIO BY THE METHOD OF GAMMA-GAMMA COINCIDENCES.

A. F. Dunaitsev, V. S. Pantuev, Yu. D. Prokoshkin, Tang Syao-wei, and M. N. Khachaturyan (Joint Inst. for Nuclear Research, Dubna, USSR). p.181-2 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The ratio of the probability of two capture processes of stopped negative pions in hydrogen, $\pi^- + p \rightarrow \pi^0 + n \rightarrow \gamma' + \gamma'' + n$ and $\pi^- + p \rightarrow \gamma + n$, was determined by the method of γ-γ coincidences for a 65-Mev meson (π^-) beam. The following values were obtained for the Panofsky ratio: 1.38 ± 0.08, 1.45 ± 0.08, 1.33 ± 0.11, and 1.41 ± 0.13. (M.C.G.)

9807 TRIPLE PION PRODUCTION AT 810, 970, AND 1110 MeV. V. P. Kenney, J. G. Dardis, and G. Brunhart (Univ. of Kentucky, Lexington). p.183-5 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A study was made of N-π collisions in order to determine if a pion transition between either of the $T = \frac{1}{2}$ levels and the $T = \frac{3}{2}$ level led to triple meson (π) production according to the scheme $\pi + N \rightarrow N^*_\delta \rightarrow I^*_{\frac{1}{2}} + \pi \rightarrow I^*_{\frac{3}{2}} + \pi + \pi \rightarrow N + \pi + \pi + \pi$. Interactions of the type $\pi^- + p \rightarrow p + \pi^+ + \pi^- + \pi^-$ were identified in data from the Berkeley hydrogen bubble chamber. The momenta, angle between emerging particles, Q values, and scattering angles were determined. (M.C.G.)

9808 π^--p INTERACTIONS AT 225 MeV. J. Deahl, M. Derrick, J. Fetkovich, T. Fields, and G. B. Yodh (Carnegie Inst. of Tech., Pittsburgh, Penna). p.185-7 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Meson (π^-) interactions with protons at 225 Mev were studied in order to obtain scattering data of higher accuracy than that previously available and to observe meson (π) production. Total and elastic differential cross sections were determined. An s,p phase-shift analysis was made on the data. (M.C.G.)

9809 π^+-p ELASTIC SCATTERING AT 120 MeV. A. Loria (Istituto di Fisica dell'Università, Padua, Italy), P. Mittner, R. Santangelo, G. Zago, A. Brenner, F. Grard, and J. L. Montanet. p.188-9 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An investigation was made of the elastic scattering of 120-Mev mesons (π^+) obtained by exposing a liquid propane bubble chamber to the CERN 600-Mev synchrocyclotron. Differential cross sections and angular distributions were determined. Results of a phase-shift analysis are given. (M.C.G.)

9810 MEASUREMENT OF THE TOTAL CROSS SECTION FOR π^--p CHARGE EXCHANGE FROM T_π = 0.4 GeV TO T_π = 1.5 GeV. J. C. Brisson, P. Falk-Vairant, J. P. Merlo, P. Sonderegger, R. Turlay, and G. Valladas (Centre d'Études Nucléaires, Saclay, France). p.191-3 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The total cross section for charge exchange of mesons (π^-) on hydrogen ($\pi^- + p \rightarrow \pi^0 + n$) was determined. This was done by measuring the number of mesons (π^-) which interacted in a liquid hydrogen target without triggering a 4π-scintillation counter surrounding the target. The total cross section for neutral events showed maxima at energies close to the resonances in the π^--p total cross section. (M.C.G.)

9811 ELASTIC SCATTERING OF 142 MeV NEGATIVE PIONS BY DEUTERONS. E. G. Pewitt, G. B. Yodh, M. Derrick, J. Fetkovich, and T. Fields (Carnegie Inst. of Tech., Pittsburgh, Penna.). p.196-8 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A measurement of elastic π-d scattering at 142 Mev was undertaken in order to provide experimental data to compare with the results of impulse approximation calculations. A negative pion beam was used to bombard a deuterium bubble chamber. The method used for the selection of elastic π-d scattering tracks is given. The experimental results were found to be at variance with the theory that is based on the impulse approximation and takes into account double scattering, some recoil effects, and the D state of the deuteron. (M.C.G.)

9812 THE NUCLEON-NUCLEON REPULSIVE CORE AND THE SPIN-ORBIT INTERACTION. G. Breit (Yale Univ., New Haven, Conn.). p.198-9 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960." (TID-6114)

In explanations of the phenomenological repulsive core and the spin-orbit term in nucleon-nucleon interactions, some uncertainties regarding the large and small masses were found. Reasons for these uncertainties are outlined. The possibility that the phenomenological core is a substitute for a condition which makes the shape of the wave function similar to that obtained by enforcing a node at the core radius is also discussed. (M.C.G.)

9813 PROTON-PROTON DIFFERENTIAL CROSS SECTION AT 1 BeV. J. D. Dowell, W. R. Frisken, G. Martelli, B. Musgrave, H. B. van der Raay, and R. Rubinstein (Univ. of Birmingham, England). p.202 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The p-p elastic differential cross section in the angular range 18 to 90° was measured at 1010 ± 20 Mev, using a polythene-carbon difference method. The results, corrected for accidental coincidences, were fitted with curves of the form $\sigma(\theta) = \sum_{l=0}^{l\,\max} \alpha_{2l} P_{2l} (\cos\theta)$ using a least squares method. The absolute values of the differential cross section were obtained by normalizing the intercept of the fitted curve. (M.C.G.)

9814 PROTON-PROTON INTERACTIONS AT 2.85 BeV. G. Smith, H. Courant, E. Fowler, H. Kraybill, J. Sandweiss, and H. Taft (Yale Univ., New Haven, Conn.). p.203-4 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An analysis was made of proton-proton elastic scattering using a liquid hydrogen bubble chamber and 2.85-Bev protons from the Cosmotron. The total cross section composed from the diffracting disk model agreed well with the experimental data. Inelastic two-prong events in which pion production took place were also measured. The cross section for single meson production was found to be 15.2 ± 1.0 mb. (M.C.G.)

9815 EXTENSION OF THE ISOBARIC NUCLEON MODEL FOR PION PRODUCTION IN π-N, N-N, AND $\overline{N}$-N COLLISIONS. S. J. Lindenbaum and R. M. Sternheimer (Brookhaven National Lab., Upton, N. Y.). p.205-7 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An extension was made of the isobaric nucleon model by including two higher energy $T = \frac{1}{2}$ isobaric states of the nucleon. Three-pion final states in π-N collisions were considered. Branching ratios for pion production in π^+-p, π^--p, and p-p interactions are given. (M.C.G.)

9816 MANY-PARTICLE STRUCTURE OF GREEN'S FUNCTIONS. K. Symanzik (Univ. of California, Los Angeles). p.211-19 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The method of structure analysis of Green's functions is described. A theory with a scalar Hermitian irreducible field and with one kind of neutral spinless particles of mass m only is discussed. In the absorptive part of the irreducible functions neither intermediate states with the particle number for which irreducibility was imposed nor reducibilities in the same number of particle lines, whether or not they could give rise to a singularity, appeared. TCP invariance and crossing symmetry were not satisfied by the solution. The structure-analytical considerations gave only moderate support to the assumption that the perturbation theory can not mislead as far as analytical properties are concerned. (M.C.G.)

9817 THE USE OF PERTURBATION METHODS IN DISPERSION THEORY. R. J. Eden (Univ. of California, Berkeley). p.219-29 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960." (UCRL-9345)

Proofs of dispersion relations for every order in the perturbation theory are given. Integral thresholds and representations of production amplitudes are reviewed. Some points connected with experiments on final-state interactions in which production amplitudes are involved are discussed. The proofs are outlined and the mathematical methods on which they are based are indicated. Single-variable dispersion relations, partial-wave dispersion relations, the Mandelstam representation, and anomalous thresholds are discussed. (M.C.G.)

9818 PROBLEMS OF MAJORIZATION OF FEYNMAN DIAGRAMS. A. A. Logunov (Joint Inst. for Nuclear Research, Dubna, USSR). p.230-1 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A method for the majorization of diagrams is discussed. It was found that each diagram can be majorized by any of its sub-diagrams. Theorems were also developed to compare primitive diagrams with one another. (M.C.G.)

9819 THE MANDELSTAM REPRESENTATION IN PERTURBATION THEORY. P. V. Landshoff, J. C. Polkinghorne, and J. C. Taylor (Univ. of Cambridge, England). p.232-6 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

It is shown that the Mandelstam representation holds to every finite order of perturbation theory under the conditions that no anomalous vertex thresholds exist. An induction procedure was used to consider the leading singularity at each stage of a Feynman graph. Behavior of singularities, reality conditions, methods of by-passing cuts, nonsingularity, and unitarity conditions are discussed. (M.C.G.)

9820 A GENERALIZED UNITARITY RELATION. R. E. Cutkosky (Carnegie Inst. of Tech., Pittsburgh, Penna.). p.236-43 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Proof is presented for a general unitarity relation to supplement Landau's theorem that only a reduced Feynmann graph is needed to study singularities of perturbation theory amplitude. The Feynmann integral was rewritten in terms of the virtual masses of the intermediate particles. When the virtual masses of the particles in the reduced graph are not independent, there is one less integration variable than there are poles. Applications of the relation to the problems of Mandelstam's representation of scattering amplitudes and of the electromagnetic form factor of the deuteron are discussed. (M.C.G.)

9821 THE COMPLEX SINGULARITIES OF PARTIAL WAVE AMPLITUDES IN PERTURBATION THEORY. J. G. Taylor and A. E. A. Warburton (Univ. of Cambridge, England). p.243-4 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

It is shown that the complex singularities which invalidate Mandelstam's representation do not cause complex singularities of the partial-wave amplitudes. However, if the outgoing particles differ from the incoming particles, there are "kinematic" complex branch points. (M.C.G.)

9822 UNPHYSICAL RIEMANN SHEETS. R. Blankenbecler (Princeton Univ., N. J.). p.247-54 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A general approach to the analytic properties on the second Riemann sheet is discussed. The case of individual partial waves for the scattering of scalar particles was considered. A discussion of the scattering amplitude without expanding in partial waves is presented. Applications of the results to the problems of anomalous thresholds and bound states are required. (M.C.G.)

9823 PERTURBATION THEORY WITHOUT HAMILTONIAN. K. Nishijima (Univ. of Illinois, Urbana). p.254-9 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An S matrix formulation of field theory is discussed. Two kinds of universal relationships are postulated in this formalism: the generalized unitarity condition and the parametric dispersion relations for Green's functions. Subtractions were found to be necessary in the parametric dispersion relations in order to introduce interactions. The number of subtractions determines the type of interaction in the corresponding conventional field theory. It is shown that this formulation can reproduce the renormalized perturbation theory series expansion up to the third order without encountering any divergences in the course of calculation. (M.C.G.)

9824 A NEW REDUCTION TECHNIQUE IN QUANTUM FIELD THEORY. J. S. Toll (Univ. of Maryland, College Park). p.259-69 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A new technique is presented for reduction of the scattering matrix or other physical quantities in quantum field theory. It has the advantage over the Lehmann, Symanzik, and Zimmermann method of yielding a larger primitive domain of analyticity and of not requiring local commutativity. The method is illustrated for the case of two-particle scattering and for the vertex function. It is shown that, without additional assumptions, the reduction technique has only trivial consequences, for it is proved that any matrix element can be chosen as an arbitrary invariant function of the energies and momentum transfers involved and that it can still be extended off the mass shell to satisfy the analyticity and mass spectrum conditions. (M.C.G.)

9825 THE STRUCTURE OF THE NON-RELATIVISTIC SCATTERING MATRIX. R. G. Newton (Indiana Univ., Bloomington). p.270-1 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The results of Le Couteur, that under certain conditions there exists a single function of n complex variables from which all elements of an n-channel nonrelativistic S matrix are obtainable, were generalized. It was found that the relevant function is the Fredholm determinant of the set of coupled integral equations for the scattering wave function. It was determined that the S matrix is analytic on the first sheet of the Riemann surface of the energy plane, except for a branch cut. (M.C.G.)

9826 DISPERSION RELATIONS AND THE CAUSALITY CONCEPT. J. M. Lozano and M. Moshinsky (Instituto de Física, Universidad de México, México, D.F.). p.271-2 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A dispersion function, which is the Laplace transform of the time-dependent Green function, was obtained using a causality principle. This principle states that the time-dependent Green function for scattering by an arbitrary potential should be bounded for all times. (M.C.G.)

9827 THE PION-PION INTERACTION. G. F. Chew (Univ. of California, Berkeley). p.273-7 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Pion-pion interactions in which the P phase shift may be large at low energies were studied. It was found that equations formulated with a single arbitrary constant λ to represent all forces of range shorter than those transmitted by exchange of S and P wave pairs were no longer sufficient. Results showed that the very short-range attractive force due to exchange of a resonating P wave pair is very strong, violating requirements of unitarity and analyticity. An additional arbitrary parameter was introduced into the equation. (M.C.G.)

9828 THE DERIVATIONS OF THE $\pi\pi$ AND πN SCATTERING FROM THE MANDELSTAM REPRESENTATION. A. V. Efremov, V. A. Meshcheryakov, D. V. Shirkov, and Hun-Yuan Tzu. p.278-82 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The errors introduced in studies of π-π and π-N scattering by the two-particle state approximation of unitary condition and the approximation neglecting the contribution from higher angular momentum starts are discussed. In a general approach to the problem of deriving integral equations for low-energy processes from dispersion relations and unitary conditions, those reaction angles were chosen for which the Legendre expansion fails only at the distant part of the unphysical region. By limiting the contributions from the amplitudes of the reaction $\pi + \pi \rightarrow N + \overline{N}$ to those of s and p waves, a closed system of equations for the partial waves of the π-N scattering was obtained. (M.C.G.)

9829 APPLICATION OF THE MANDELSTAM REPRESENTATION TO PION-NUCLEON SCATTERING. W. R. Frazer (Univ. of California, Berkeley). p.282-7 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960." (UCRL-9396)

Methods of obtaining theoretical predictions for pion-nucleon scattering from the Mandelstam representation are discussed. Two approaches to the problem are presented: the partial wave dispersion relations and a modification of the method of Chew, Goldberger, Low, and Nambu. Crossing symmetry was used to reduce the number of parameters. The short-range forces were treated phenomenologically by representing them by poles or subtraction constants. (M.C.G.)

9830 DISPERSION RELATION FOR THE S-WAVE PARTIAL AMPLITUDE IN PION-NUCLEON SCATTERING. J. Hamilton (Univ. of Cambridge, England). p.288-92 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

To obtain the singularities of the s-wave partial amplitude, the amplitude was related to the usual invariant amplitudes which have a Mandelstam representation. It was found that the Born terms are negligible in the s-wave case, except for a very short-range contribution. The rescattering and crossing terms were of the same order of magnitude as the scattering amplitude itself. Results suggested that the large values of π-π scattering amplitude occurred at an energy no greater than $12\,\mu^2$, where μ is the pion mass. (M.C.G.)

9831 THE $N\overline{N}$-$\pi\pi$ AMPLITUDE. D. Y. Wong (Univ. of California, Berkeley). p.292-5 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The determination of the $N + \overline{N} \rightarrow \pi + \pi$ amplitude in terms of known singularities of the function is described. The region studied was that in which the energy of the nucleon-antinucleon system was not far from twice the pion mass. Two modifications of the Frazer-Fulco solution are reported. The compatibility of the π-π parameters with the dispersion theory of Chew and Mandelstam is discussed. (M.C.G.)

9832 SINGULARITIES OF THE SCATTERING AMPLITUDE IN PERTURBATION THEORY. A. Z. Pitashinsky, A. P. Rudik, and V. V. Sudakov. p.296-7 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Relations are given which reduce the problem of finding the singularities of an arbitrary scattering diagram to the problem of finding the singularities of the "envelope" diagram with certain effective masses which depend on the variables s and t. In the asymptotic case, the minorants for these effective masses can be found. It can also be determined whether asymptotic singularities of the anomalous type are present. (M.C.G.)

9833 NEAREST SINGULAR POINTS IN THE PION-PION SCATTERING PROBLEM. V. A. Kolkunov, L. B. Okun, A. P. Rudik, and V. V. Sudakov (Institute of Theoretical and Experimental Physics, Moscow, USSR). p.297 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Curves of singularities for pion-pion scattering were found for some diagrams in which the intermediate states have four mesons. (M.C.G.)

9834 PION PRODUCTION BY PIONS AND THE SECOND PION-NUCLEON RESONANCE. C. Goebel and H. J. Schnitzer (Univ. of Rochester, N. Y.). p.298-302 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The process $\pi + N \rightarrow \pi^+ + \pi^- + N$ was investigated from threshold to 600 Mev. The mechanism was assumed to be the exchange of one π or a knock-on collision. The final state π-π interaction was treated essentially as in the Chew-Low theory of photoproduction. The cross sections and charge ratios of the cross sections for p-π interactions are given. (M.C.G.)

9835 DETERMINATION OF THE RENORMALIZED π-N COUPLING CONSTANT. W. S. Woolcock (Univ. of Cambridge, England). p.302-3 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An attempt was made to improve the results obtained by Spearman for the renormalized π-N coupling constant. The dispersion relation for the invariant amplitude B in the forward direction was used. Averaging 24 results gave a value of 0.080 ± 0.0014 for the coupling constant. Allowing for the possible additional error due to the high-energy π^+-p resonance, the final value was 0.080 ± 0.002. (M.C.G.)

9836 DOUBLE DISPERSION APPROACH TO NUCLEON-NUCLEON SCATTERING. S. W. MacDowell (Princeton Univ., New Jersey). p.304-9 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The nucleon-nucleon scattering problem was investigated on the basis of the double dispersion representation. A set of five invariant amplitudes, free from kinematical singularities, was chosen to describe two-nucleon scattering. It is shown that the amplitude possesses a Mandelstam representation. A partial-wave analysis was made of the scattering amplitude in the center-of-mass system. The partial-wave dispersion relations were deduced from the Mandelstam representation by locating the singularities of the partial-wave amplitudes which occur whenever one of the denominators which appear in the Mandelstam representation vanishes. A discussion of nucleon-antinucleon scattering is also included. (M.C.G.)

9837 ONE DIMENSIONAL REPRESENTATION FOR LOW ENERGY PION PHENOMENA. M. Cini (Univ. of Rome, Italy) and S. Fubini. p.310-19 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A general approach to the study of strong π-N interactions is discussed. This approach shows that a consistent procedure for treating the effect of inelastic processes on low-energy scattering leads to the reduction of the two-dimensional integral representation to a one-dimensional representation which has the correct analytic properties in all variables, fulfills the crossing conditions, and is approximately unitary. The physical approximations leading to this one-dimensional representation are essentially the same as those involved in the Chew–Mandelstam approach. (M.C.G.)

9838 RELATIVISTIC DISPERSION APPROACH TO PION PHOTOPRODUCTION NEAR THRESHOLD. A. M. Baldin (Lebedev Physical Institute, Moscow, USSR). p.325-32 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The formulation of certain propositions on whose basis it is possible to evaluate pion photoproduction data near the threshold is discussed. It was found that discrepancies between the dispersion relations and experimental data could be explained on the basis of the large contribution of the unobservable energy region to the dispersion integrals. Analyses were performed for the photoproduction of π^+ and π^0 mesons. One region was found in which no disagreements between theory and experiment occurred. This region corresponded to the values of momentum transfer which differed very little from the momentum transfer at the threshold. (M.C.G.)

9839 ON THE ASYMPTOTIC BEHAVIOR OF CROSS SECTIONS AT HIGH ENERGIES. V. B. Berestetskiĭ and I. Ya. Pomeranchuk (Institute of Theoretical and Experimental Physics, Moscow, USSR). p.333-40 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Processes for the transformation of two particles into three or four particles were examined in the pole approximation. In the energy range in which the total elastic scattering cross section is independent of energy, the cross section for the transformation of two particles into three did not decrease with increasing energy. The cross section for the transformation of two particles into four exhibited a logarithmic growth with energy. Data indicated that with increasing energy the total effective cross section approached a constant limit. It was found that although the cross section for shower production is not large, it does not diminish with an increase in energy. The angular distribution and energy spectrum of the π meson produced in N-N interactions were calculated. (M.C.G.)

9840 ON THE ASYMPTOTIC BEHAVIOR OF SCATTERING AMPLITUDES AT HIGH ENERGIES. V. N. Gribov (Physical-Technical Inst., Leningrad, USSR). p.340-7 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The asymptotic behavior of scattering amplitudes was investigated at high energies. The Mandelstam representation of the scattering amplitude in the form sf(t), which holds if the scattering is of diffractional character, was found to contradict unitarity conditions and analytic prop-

erties. A decrease was found in cross section faster than $(\ln E)^{-1}$. (M.C.G.)

9841 SINGLE VIRTUAL BOSON EXCHANGE EFFECTS IN HIGH ENERGY COLLISIONS. G. Salzman (Univ. of Colorado, Boulder). p.348-50 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An examination of the single boson exchange model was made in an attempt to supplement the statistical theories by adding some information about the matrix elements involved. For small values of momentum the virtual boson behaved kinematically as an incoming, almost-real, particle in collisions. The single boson exchange effects were studied in meson (π)-nucleon collisions. (M.C.G.)

9842 TWO PARTICLE SINGULARITIES OF THE SCATTERING AMPLITUDE. W. Zimmermann (Univ. of Hamburg, Germany). p.351-2 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Analytic properties and the unitarity condition of a causal and invariant scalar field operator A(x), describing a system of identical particles of mass m and charge and spin zero, were used for separating the two-particle singularities from the scattering amplitude. It is shown that the scattering amplitude has a branch point of the type $\sqrt{s-4m^2}$ at $s = 4m^2$, where s is the square of the energy. (M.C.G.)

9843 ON THE PION-PION INTERACTION. J. G. Taylor (Univ. of Cambridge, England). p.353-4 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An approach to the S and P wave pion-pion amplitudes, different from that of Chew and Mandelstam, is described. The number of free parameters involved in the dispersion relations was determined. Equations determining the partial-wave amplitude were found to require one parameter for the S wave and two for the P wave. The characteristics of wave amplitudes were determined from unitarity, cut plane analyticity, and crossing symmetry. (M.C.G.)

9844 ON THE P-WAVE RESONANCE AND THE UNPHYSICAL REGION IN PION-PION SCATTERING. J. W. Moffat (RIAS, Baltimore, Md.). p.355-6 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The pion-pion partial-wave amplitude was determined in terms of the unitarity condition and the branch cuts and poles of the inverse amplitude. An iteration procedure was developed in order to estimate the influence of the unphysical region on the behavior of the P-wave pion-pion resonance. The shift of the resonance position due to the contribution of the left-hand branch cut was determined. (M.C.G.)

9845 $\pi\pi$ INTERACTIONS IN πN COLLISIONS AT HIGH PION ENERGIES. D. I. Blokhintsev and Wang Yung (Joint Inst. for Nuclear Research, Dubna, USSR). p.357-8 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The role of π-π interactions in π-N collisions was investigated when the momentum of the primary pion was about 7 Bev/c. The contribution to elastic π-N scattering was found to be small and comparable with experimental errors. In the case of inelastic collisions, the contribution from the π-π interaction was quite noticeable and it was possible to determine the cross section for π-π interactions from data on multiple pion production. Typical cross sections ranged from 15 to 30 mb for a momentum of 680 Mev/c. (M.C.G.)

9846 CALCULATION OF PION-NUCLEON SCATTERING PHASE SHIFTS FROM DISPERSION RELATIONS. G. Höhler and K. Dietz (Technische Hochschule, Karlsruhe, Germany). p.359-60 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Pion-nucleon scattering phase shifts calculated by Chew et al. resulted in fairly large errors. For this region a more accurate treatment was developed. The correct evaluation of the recoil effects led to a value 2.8 times lower than the 1/M-approximation. The exact expression for the s-wave amplitude was found to deviate by 20% from the first terms of the expansion used by Chew et al. A third correction resulted from all the contributions to the dispersion integral other than the (3,3)-part. The scattering lengths of the p waves were calculated, taking into account only the (3,3)-part of the dispersion integral. (M.C.G.)

9847 THE D-WAVE DISPERSION RELATIONS FOR πN SCATTERING IN A MODEL OF PION THEORY. W. Królikowski (Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw). p.361-2 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

It was found that the model of the nucleon having the center-of-mass fixed but the core moving could be used to derive D-wave dispersion relations for π-N scattering. The Low equation for the process $N + \pi \rightarrow N + \pi$ was derived. The relations $p = p_0 + (\text{momentum of the cloud}) = 0$ and $E_p = M$, where M is the mass of the nucleon, were put into this equation. The transition matrix was split into partial waves using projection operators. Then the partial-wave Low equations were transformed into the partial-wave dispersion relations. (M.C.G.)

9848 S-WAVE MESON-NUCLEON INTERACTION AND NUCLEON CORE. S. Minami (Osaka City Univ., Japan). p.363-4 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The problems of s-wave π-N and K-N scattering were investigated. The ordinary perturbation result for the real part of the forward scattering was compared with the contribution from the bound state to the real part of the scattering amplitude in the dispersion relation. The characteristic property of K-N interactions in the nucleon core was derived in terms of the change of value of the coupling constant. An interpretation of the reduction of the coupling constant in the nucleon core from a field theoretical point of view is considered. (M.C.G.)

9849 THE THEORY OF THE SECOND RESONANCE IN THE PION-NUCLEON SCATTERING. K. Itabashi, M. Kato, K. Nakagawa, and G. Takeda (Inst. for Nuclear Study, Tokyo Univ., Japan). p.364-5 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The theory of the second and third resonances in π-N

scattering and meson (π) photoproduction on nucleons is discussed. The π-N scattering amplitude in Born approximation through the p-N intermediate state ($\pi + N \rightarrow p - N \rightarrow \pi + N$) was calculated. The result corresponded to a strong attractive potential between the meson (π) and the nucleon. The potential's depth was four times larger for the $T = \frac{1}{2}$ state than for the $T = \frac{3}{2}$ state. The π-N scattering in the $d_{\frac{3}{2}}$, $T = \frac{1}{2}$ state was investigated by the Tamm-Dancoff approximation. (M.C.G.)

9850 PHOTOPRODUCTION OF STRANGE PARTICLES. F. Turkot (Cornell Univ., Ithaca, N. Y.). p.369-71 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Present experimental knowledge on the photoproduction of strange particles is summarized. Information was obtained on the following reactions: $\gamma + p \rightarrow K^+ + \Lambda^0$, $\gamma + p \rightarrow K^+ + \Sigma^0$, and $\gamma + N \rightarrow K^+ + \Sigma^-$. Angular distributions and excitation curves are given. (M.C.G.)

9851 PRODUCTION OF STRANGE PARTICLES IN p-p COLLISIONS AT 2.85 BeV. R. I. Louttit, T. W. Morris, D. C. Rahm, R. R. Rau, A. M. Thorndike, and W. J. Willis (Brookhaven National Lab., Upton, N. Y.). p.372-6 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A liquid hydrogen bubble chamber was used to determine total and partial cross sections for strange particle production in p-p interactions. Of the 162 production events observed, only the 91 showing hyperon decay were used. A value of 130 ± 30 mb was found as the total cross section for hyperon production. Partial cross sections are given for various reactions. The ratio of predicted to experimental values for cross section was also determined. (M.C.G.)

9852 Σ^- PRODUCTION NEAR THRESHOLD. M. H. Alston, J. A. Anderson, P. G. Burke, D. D. Carmony, F. S. Crawford, N. Schmitz, and S. E. Wolf (Univ. of California, Berkeley). p.377 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The reaction $\pi^- + p \rightarrow \Sigma^- + K^+$ was observed in a hydrogen bubble chamber. Two plots of angular distribution in the energy ranges from 0 to 10 and 10 to 20 Mev were consistent with S-wave scattering. The production cross section is given as a function of the mean pion excitation energy. (M.C.G.)

9853 DETECTION OF A CUSP IN Λ^0K^0 PRODUCTION AT ΣK THRESHOLD. M. H. Alston, J. A. Anderson, P. G. Burke, D. D. Carmony, F. S. Crawford, N. Schmitz, and S. E. Wolf (Univ. of California, Berkeley). p.378-81 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Preliminary results from a hydrogen chamber experiment now in progress suggest a Cusp behavior for the reaction $\pi^- + p \rightarrow K^0 + \Lambda^0$ at 1034 Mev/c, the threshold for production of Σ^-K^+. The observed effect had a sharp momentum dependence. The Landau straggling of energy loss of pions and momentum resolution is considered. The angular distributions were determined. Both the production and decay asymmetry showed rapid variation at threshold. (M.C.G.)

9854 THE CROSS SECTION RATIO $\eta = \sigma(K^0,\overline{K}^0)/(\sigma(\Lambda,K^0) + \sigma(\Sigma^0,K^0))$ FOR STRANGE PARTICLES PRODUCED BY 2.8 BeV/c π^--MESONS ON XENON NUCLEI. E. V. Kuznetsov (Inst. of Theoretical and Experimental Physics, USSR), I. A. Ivanovskaya, A. Prokesh, and I. V. Chuvilo. p.382 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The cross section ratio, η, for strange particles produced in a xenon bubble chamber in the reactions $\pi^- + Xe \rightarrow \Lambda^0(\Sigma^0) + K^0 + Xe' + \eta\pi$ and $\pi^- + Xe \rightarrow K^0 + \overline{K}^0 + Xe' + \eta\pi$ was measured. If only reliably identified cases were taken into account the value obtained for η was 0.54 ± 0.18. If certain events were excluded the value changed to 0.66 ± 0.20. (M.C.G.)

9855 TRANSVERSE POLARIZATION OF Λ^0-HYPERONS PRODUCED BY 2.8 BeV/c π^--MESONS ON XENON NUCLEI. E. V. Kuznetsov (Inst. of Theoretical and Experimental Physics, USSR), I. A. Ivanovskaya, A. Prokesh, and I. V. Chuvilo. p.383-4 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The "up-down" asymmetry in the decay of Λ^0 hyperons produced by 2.8 ± 0.3 Bev/c π^- mesons in a xenon bubble chamber in the reaction $\pi^- + Xe \rightarrow \Lambda^0 + K + Xe' + \eta\pi$ was investigated. A value of 0.08 ± 0.14 was obtained for $\alpha\overline{P}$, where $\overline{P}$ is the polarization of the Λ^0 hyperon averaged over the production angles and α is a coefficient characterizing the degree of parity nonconservation. (M.C.G.)

9856 ON PARITY CONSERVATION IN Λ-HYPERON PRODUCTION. E. V. Kuznetsov (Inst. of Theoretical and Experimental Physics, USSR), I. A. Ivanovskaya, A. Prokesh and I. V. Chuvilo. p.384-7 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, N. Y., August 25–September 1, 1960."

The forward-backward asymmetry in the decay of Λ^0 hyperons produced by 2.8 ± 0.3 Bev/c mesons (π^-) in a xenon bubble chamber was measured. The angular distribution of the decay products was assumed to be described by the relation $1 + \alpha\overline{P}\cos\theta$. In left-right and up-down asymmetry, values of 0.27 ± 0.14 and 0.24 ± 0.17 were obtained for $\alpha\overline{P}$. No conclusion could be drawn about the conservation or violation of parity from these results. (M.C.G.)

9857 STRANGE PARTICLE PRODUCTION IN πp-COLLISIONS AT 7-8 BeV. M. I. Soloviev (Joint Inst. for Nuclear Research, Dubna, USSR). p.388-402 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, N. Y., August 25–September 1, 1960."

The production of $\Lambda^0(\Sigma^0)$, $\Sigma^\pm$, and Ξ^- hyperons and K^0 mesons was investigated in π-p interactions at 7 and 8 Bev/c. The total production cross section for $\Lambda^0(\Sigma^0)$ hyperons and K^0 mesons was found to be 2.0 ± 0.35 mb. For Y^0K and $K\overline{K}$ pairs, values of 0.8 ± 0.25 and 1.2 ± 0.3 mb were obtained. Angular and momentum distributions of Λ^0 hyperons, K^0 mesons, secondary π^- mesons, and Σ hyperons were determined. Eleven events of Ξ^- hyperon production were found. The production cross sections were $3.6^{+2.2}_{-2.1}$ and $10.6^{+4.4}_{-3.2}$ μb per nucleon at 7 and 8 Bev/c, respectively. The simultaneous production of more than two strange particles was investigated. In 102,000 photographs 5 cases of more than two strange particles being produced were found. The decay asymmetry of Λ^0 hyperons was studied. (M.C.G.)

9858 STRANGE PARTICLE PRODUCTION IN 16 GeV π^--p INTERACTIONS. J. Bartke, R. Bock, et al. (CERN, Geneva, Switzerland). p.402-5 of "Proceedings of the 1960

Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A hydrogen bubble chamber was exposed to a beam of 16-Bev π^- mesons. The total interaction cross section was determined as 26.5 ± 1.7 mb. Angular and momentum distributions are given for K^0 mesons and Λ^0 hyperons produced in the reactions. A sharp peak was found in the backward direction for Λ^0. (M.C.G.)

9859 INVESTIGATION AT 1.15 GeV/c OF THE ASSOCIATED PRODUCTION $\pi^+ + p \rightarrow \Sigma^+ + K^+$. A. Berthelot, A. Daudin, et al. (Centre d'Etudes Nucléaires, Saclay, France). p.406-7 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An investigation was made of 81 associated production events $\pi^+ + p \rightarrow \Sigma^+ + K^+$ by means of a propane bubble chamber. Absolute differential cross sections and angular distributions were determined. Results gave a total production cross section of 0.26 ± 0.05 mb. (M.C.G.)

9860 K^- CAPTURE PROCESS AND K^- NUCLEAR INTERACTIONS. G. A. Snow (Univ. of Maryland, College Park). p.407-14 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The orbital angular momentum states from which negative particles such as K^- could be captured at rest in liquid hydrogen, deuterium, and helium are discussed. Capture appeared to be predominantly from the s-state. The importance of the Stark effect in nuclear capture from the higher n states is described. Meson (K^-)-proton interactions at low energy were also investigated. The production ratios for the various hyperons are given. (M.C.G.)

9861 K^- INTERACTIONS IN DEUTERIUM. O. Dahl, N. Horwitz, D. Miller, J. Murray, and M. Watson (Lawrence Radiation Lab., Univ. of California, Berkeley). p.415-19 of "Proceedings of the 1960 Annual International Conference on High Energy at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The systematic investigation of K^- interactions in deuterium was continued. Because of the importance of the (Σ^-,n) bound state in the determination of parity, a search was made for this system in 1800 events. Two events were found that could reasonably be interpreted as examples of production of a bound (Σ^-,n) system. The analysis of K^--d interactions was extended to 300 Mev/c. The absorption on protons and neutrons for hyperon production is summarized. (M.C.G.)

9862 HYPERFRAGMENT FORMATION IN $K^- + He^4$ CAPTURES AT REST AND K–Λ RELATIVE PARITY. M. M. Block, E. B. Brucker, et al. (Duke Univ., Durham, N. C.). p.419-22 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, N. Y., August 25–September 1, 1960."

The systematics of hyperfragment formation in K^-–He^4 interactions, in particular the absolute and relative rates of formation, are discussed. The production reactions $K^- + He^4 \rightarrow {}_{\Lambda}He^4 + \pi^-$ and $K^- + He^4 \rightarrow {}_{\Lambda}H^4 + \pi^0$ were investigated. The various decay modes are discussed and illustrated. Spin assignments and relative K–Λ parity were also studied. (M.C.G.)

9863 THE Σ–Λ CONVERSION PROCESS IN K^-–He ABSORPTION. M. M. Block, E. B. Brucker, et al. (Duke Univ., Durham, N. C.). p.423-6 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Single nucleon absorption was found to be the predominant mechanism in K^-–He^4 interactions. This process has three channels: direct Λ production, direct Σ production, and Σ → Λ conversion. An estimate of the relative fractions of these reactions was obtained by studying the pion momentum spectrum. It was found that the fraction of Σ hyperons which convert to Λ hyperons relative to the total number present in the initial single nucleon interaction is approximately 50%. No evidence of parity nonconservation was found in the Σ →Λ conversion process. (M.C.G.)

9864 K^- INTERACTIONS AT REST IN HELIUM. M. Block, E. B. Brucker, et al. (Duke Univ., Durham, N. C.). p.426-31 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A study was made of K^- interactions at rest in helium. The fraction of multinucleon capture was determined and found to be 17 ± 4%. The reactions $K^- + He^4 \rightarrow \Sigma^+ + \pi^- + H^3$, $K^- + He^4 \rightarrow \Sigma^- + \pi^+ + H^3$, and $K^- + He^4 \rightarrow \Lambda^0 + \pi^- + He^3$ were analyzed. The rates of the first two equations, compared to the total number of cases in which a Σ^+ and π^- emerged, were found to be 64 ± 10% for the first and 63 ± 10% for the second reaction. It was found that the probability that an H^3 or and He^3 emerge when a Σ or Λ is produced is dependent on the energy release. A model for these interactions is discussed. (M.C.G.)

9865 ON THE MULTI-NUCLEON CAPTURE OF K^--MESONS. G. Alexander, Y. Eisenberg, M. Friedman, and D. Kessler (Weizmann Inst. of Science, Rehovoth, Israel). p.432-4 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

It was found that over 30% of all K^- captures at rest in nuclear emulsions proceed by the reaction $K^- + 2N \rightarrow Y + N$. An attempt was made to establish a correlation between typical one- and two-nucleon events. The yield of Auger electrons was found to be much larger in the two-nucleon events than in one-nucleon absorption. Most of the two-nucleon events took place in the heavy AgBr rather than the light CNO emulsions. An analysis was made of the two-nucleon events which yielded fast Σ hyperons. (M.C.G.)

9866 SOME EVIDENCE FOR FAST Σ HYPERON PRODUCTION BY K^- MESON INTERACTIONS WITH LIGHT NUCLEI IN EMULSION. D. Evans, B. D. Jones, B. Sanjeevaiah, J. Zakrzewski (Univ. of Bristol, England), and D. H. Davis. p.435-6 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

It was found that multinucleon capture does occur in C, N, and O in emulsions. Σ hyperons with energies greater than 60 Mev were produced by K^- meson interactions with C^{12} and N^{14}. (M.C.G.)

9867 EMULSION WORK ON STRANGE PARTICLES. p.436-42 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Among tracks from K^- absorptions in a stack of nuclear emulsions, π^--mesonic hyperfragments were found. No significant difference was found between the charge and baryon

number spectra of hyperfragments produced by K^- and π^- mesons. The lifetime of ${}_{\Lambda}H^4$ was calculated. In a sample of 90 identified mesonic hyperfragments, no evidence was found for the decay mode $(\Lambda p) \rightarrow N + N + \pi^+$. The search for radiative decay of Σ^+ was continued but no more cases were detected. Two events were observed in which a Σ^+ decay was associated with an electron pair. The absorption of Σ^- hyperons produced in K^- capture by protons was investigated. The angular distribution of pions from Λ decay was also determined. (M.C.G.)

9868 TOTAL CROSS SECTION FOR π^--p INTERACTION AT HIGH ENERGY. A. S. Vovenko, B. A. Kulakov, A. L. Lubimov, Y. A. Matulenko, I. A. Savin, E. V. Smirnov, and M. D. Shafranov (Joint Inst. for Nuclear Research, Dubna, USSR). p.443 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The total cross section for π^--p interactions at a momentum of 7.0 Bev/c was measured by the CH_2-C subtraction method. The momentum of the mesons (π^-) was determined by the current-carrying wire method. The value obtained for the cross section was 27.8 ± 0.8 mb. (M.C.G.)

9869 TOTAL CROSS SECTIONS FOR HIGH ENERGY K^+-MESONS AND π^+-MESONS. Chzan Nai-sen, Sui Yuin-chan, M. F. Lykhachev, and V. S. Stavinsky (Joint Inst. for Nuclear Research, Lab. of High Energy, Dubna, USSR). p.444-5 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The total scattering cross sections were measured for 4.75-Bev K^+ and π^+ mesons on hydrogen, carbon, aluminum, and copper, as well as for 3.7-Bev K^+ and π^+ mesons on hydrogen. Control experiments performed to check the selection of K mesons are described. (M.C.G.)

9870 K^- INTERACTIONS AT 1.15 BeV/c IN THE 15 INCH HYDROGEN BUBBLE CHAMBER. M. Alston, L. W. Alvarez, P. Eberhard, M. L. Good, W. Graziano, H. K. Ticho, and S. Wojcicki (Lawrence Radiation Lab., Univ. of California, Berkeley). p.445-51 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The reactions $K^- + p \rightarrow \Lambda^0 + \pi^+ + \pi^-$ and $K^- + p \rightarrow \Sigma^0 + \pi^+ + \pi^-$ were investigated. A value of 4 mb was found for the total cross section. Momentum spectra for the π^+ and π^- produced in the first reaction were obtained. Results indicated that the reaction is something like $K^- + p \rightarrow y^* + \pi$ followed by the y^* decaying into Λ^0 and π. The fact that y^{*+} and y^{*-} were both present indicated that there is a finite matrix element for both values of the total I-spin and that both are relatively real. (M.C.G.)

9871 STATUS REPORT ON THE K^+d AND K^+p SCATTERING EXPERIMENT. W. Chinowsky, G. Goldhaber, et al. (Lawrence Radiation Lab., Univ. of California, Berkeley). p.451-5 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Deuterium and hydrogen bubble chambers were exposed to a highly separated beam of K^+ mesons. Angular distributions and cross sections were determined. The total K^+–p cross section was found to be 14.6 ± 1.0 mb, and the pion production cross section was 1.4 ± 0.4 mb. The number of charge exchanges and the total charge exchange cross section were determined for the reaction $K^+ + d \rightarrow K^0 + p + p$. Phase-shift analyses were made of the charge exchange data assuming s-wave scattering only in the T = 1 state and s and p wave scattering in T = 0. (M.C.G.)

9872 THE K^- PROTON AND NEUTRON INTERACTION FROM 0.6 BeV TO 3.5 BeV. V. Cook, B. Cork, T. F. Hoang, D. Keefe, L. T. Kerth, W. A. Wenzel, and T. F. Zipf (Lawrence Radiation Lab., Univ , of California, Berkeley). p.456-7 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The total cross sections for K^- mesons incident on protons and deuterons were measured as functions of energy from 0.6 to 3.5 Bev. Differential scattering cross sections were determined in the angular range 4 to 25° at 1.5 Bev for k-p interactions. A value of 13.1 ± 1.2 mb was obtained. The charge-exchange cross section for $K^- + p \rightarrow \overline{K}^0 + n$ was measured at four different energies. The K^-–n cross sections were obtained by subtraction of the proton from the deuteron data and application of the Glauber correction. (M.C.G.)

9873 PARITY CONSERVATION AND SYMMETRY LAWS IN STRONG INTERACTIONS. N. Dallaporta (Univ. of Padua, Italy). p.458-67 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The possible connection, in strong interactions, between exact parity conservation and charge-state symmetries was investigated. A discussion is presented on the compatibility of two apparently opposite requisites: to introduce enough symmetries in order to deduce from them parity conservation from CP for all strong interactions, and, at the same time, introduce enough asymmetries in order to violate the unwanted selection rules, and satisfy experimental evidence. It is shown that all possible asymmetries necessary to meet the experimental situation may be made compatible with $CP \rightarrow P$ provided that all baryon states may be considered as components of a single spinor and that all operators acting on the different charge or hypercharge components of this unique spinor should be Hermitian. Procedure in the case of the doublet approximation is illustrated. Starting from the doublet approximation, the method of introducing necessary asymmetries to meet the experimental situation is described. (M.C.G.)

9874 REMARKS CONCERNING THE LOW ENERGY K-NUCLEON INTERACTION. J. D. Bjorken (Stanford Univ., California). p.467-73 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Possible dynamics of the K-N interaction and the formalism used to calculate the scattering amplitudes are discussed. The possible interactions that predominate in the low-energy scattering, in which Feynman graphs provide the major contribution to the K-N potential, were investigated. The structure of these interactions in a given angular momentum channel were found to depend critically on the K meson parity and the relative Λ-Σ parity. The large cross sections observed implied large scattering lengths. The model advanced for the calculation of scattering amplitudes did not provide enough interaction to explain K^+-p scattering. (M.C.G.)

9875 EFFECT OF PION-PION RESONANCE IN K^+p SCATTERING. B. W. Lee (Univ. of Pennsylvania, Phila-

delphia). p.473-5 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The s-wave amplitude of K^+-p scattering in the double dispersion representation was studied. The left-hand branch cut associated with the $p_{1/2}$ state was neglected in the investigation of the s-wave phase shift. The discontinuity due to two-pion intermediate states in the process $K + \bar{R} \rightarrow N + \bar{N}$ was computed. If the (K,Λ) and (K,Σ) parities were assumed odd, it was determined that the hyperon intermediate states would proceed predominantly through the p wave and make little contribution to the s wave. (M.C.G.)

9876 REMARK ON THE ABSENCE OF A RESONANCE IN K^+p SCATTERING. W. Królikowski (Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw). p.477-9 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Since no resonance was observed for K^+-p scattering, the fact that such a resonance follows from the Yukawa coupling was confirmed. The fact that no such resonance was observed led to the assumption of an additional interaction for kaons. (M.C.G.)

9877 TOTAL CROSS SECTION FOR K^+p BETWEEN 3 AND 8 GeV/c. G. von Dardel, D. H. Frisch, et al. (CERN, Geneva, Switzerland). p.484 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Interactions of mesons ($K^\pm$) with protons at 3 to 8 Bev were investigated. Total cross sections were determined. (M.C.G.)

9878 THE BINDING ENERGY OF THE HYPERTRITON. L. Abou-Hadid and K. Higgins (Univ. College, London, England). p.486-7 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The application of the variational equivalent two-body method of Feshback and Rubinow to hyperfragment binding calculations was investigated by applying the method to the hypertriton. For various values of the $_{\Lambda}H^3$ binding energy, B_Λ, and η, the depth of the Λ–N well required to give a well-behaved solution to the Euler-Lagrange equation of the variation was found. (M.C.G.)

9879 K^- INTERACTION AT 1.1 BeV/c. M. Baldo-Ceolin, A. Caforio, F. Farini, F. Ferilli, and G. Miari (Istituto di Fisica dell'Università, Bari, Italy). p.487-8 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Meson (K^-) interactions in G-5 emulsions at 1.1 Bev/c were investigated. The number of interactions is given as a function of path length. The computed mean free path, evaluated taking into consideration the correction arising from nuclear scattering, was found to be 29^{+15}_{-8} cm. (M.C.G.)

9880 REMARKS ON THE K^- AND Σ INTERACTIONS AND THE QUESTION OF GLOBAL SYMMETRY. Y. Eisenberg and D. Kessler (Weizmann Inst. of Science, Rehovoth, Israel). p.490-3 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Information on hyperon (Σ) interactions was obtained by studying meson (K^-) capture processes in nuclear emulsions. It was found that the absorption probability of the Σ^- hyperon in the same nucleus in which it is created is very large. The charge-exchange reaction had a much smaller rate than the $\Sigma + N \rightarrow \Lambda + N'$ reaction. The K^- absorption in deuterium, branching ratios for K^- capture on protons and neutrons, and the Σ^-/Σ^+ production ratio were determined. The validity of global asymmetry in these interactions is discussed. (M.C.G.)

9881 MEASUREMENT OF THE SIGN OF THE REAL PART OF THE POTENTIAL FOR K^--NUCLEAR SCATTERING. R. D. Hill, J. H. Hetherington, and D. G. Ravenhall (Univ. of Illinois, Urbana). p.493 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An analysis was made of the small-angle nuclear scattering of K^- tracks in G-5 emulsion at 30 to 80 Mev. Experimental results were compared with theoretical curves. It was concluded that the sign of the K^--nuclear potential is negative. (M.C.G.)

9882 THE STATUS OF THE CONSERVED VECTOR CURRENT HYPOTHESIS. R. P. Feynman (California Inst. of Tech., Pasadena). p.501-7 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The experimental and theoretical status of the conserved vector current hypothesis is discussed. The most direct test of the universality and conserved vector current hypothesis is that the vector parts of the β and muon decay constants are equal. An example of this, the disintegration of O^{14} to an excited state of N^{14}, is discussed. Other consequences of the conserved vector current were tested including one based on the idea that the first forbidden corrections to the Fermi coupling should be the same as the first forbidden corrections to electromagnetic coupling. (M.C.G.)

9883 CONSERVED AND PARTIALLY CONSERVED CURRENTS IN THE THEORY OF WEAK INTERACTIONS. M. Gell-Mann (California Inst. of Tech., Pasadena). p.508-13 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The possibility of a new kind of principle to determine the weak interaction current, which would also help overcome the difficulties of vector current asymmetry and the vagueness of universality, is discussed. Only charge-exchange currents were examined. The presence of known mesons, π and K, in the Lagrangian is postulated. (M.C.G.)

9884 APPLICATION OF DISPERSION RELATIONS TO WEAK INTERACTIONS. N. N. Khuri (Inst. for Advanced Study, Princeton, N. J.). p.513-22 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A review is presented of the use of dispersion relations to study the role of strong interactions in weak processes. The problems of μ capture, β decay, and decay of π^+, hyperons, $K_{\mu 2}$, K_{β}, and K_{e3} are discussed. Relations were obtained between form factors known at a few points on spectral distributions. These relations follow only after approximations which at present cannot be justified theoretically. (M.C.G.)

9885 OUTLINE OF A DISPERSION THEORY OF THREE-PARTICLE DECAYS OF REAL AND VIRTUAL PARTICLES. G. Bonnevay (Univ. of Birmingham, England). p.523-4 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The extension of the Mandelstam representation to a 5-particle reaction was simplified by assuming that two of the particles can form an unstable bound state, decaying into three other particles. This reduced the problem to the study of a 4-point function. The application of the theory to real particle decay such as $K^{\pm} \rightarrow 3\pi$ is discussed. (M.C.G.)

9886 THE PION-PION INTERACTION IN τ-DECAY. E. Lomon (McGill Univ., Montreal, Canada). p.526-8 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A departure from phase space in meson (τ) decay amounting to a 25% variation of the matrix element over the energy range of the meson (π^-) was observed. The deviations appeared to be too strong to be due to the momentum dependence of weak matrix elements or baryon loops. The final state Coulomb interaction had a weak effect in the wrong direction. This indicated that the direct final state π-π interaction caused the departure from phase space. (M.C.G.)

9887 THE MUON ABSORPTION INTERACTION. L. Wolfenstein (Carnegie Inst. of Tech., Pittsburgh, Penna.). p.529-38 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The basic reaction responsible for meson (μ) capture by nuclei is believed to be $\mu^- + p \rightarrow n + \nu$, due to a coupling of the form used in the β decay theory. Comparison of muon capture with β decay and the effects of virtual pions is discussed. Calculations of total or partial capture rates were found to depend almost entirely on the magnitudes and relative sign of a Fermi and a Gamow-Teller coupling constant. Previous measurements of capture rates were used in an attempt to determine the magnitudes of these coupling constants. The hyperfine structure effect and calculations of muon capture in D_2, He^3, and H_2 are discussed. An attempt was made to confirm the fact that the basic capture process involves a two-component neutrino with the same helicity as that in position decay. Radiative muon capture is also discussed. (M.C.G.)

9888 MEASUREMENT OF μ-MESON HELICITY. A. T. Alikanov, Tu. V. Galaktionov, Yu. V. Gorodkov, G. P. Eliseyev, and V. A. Lyubimov (Inst. for Theoretical and Experimental Physics, Moscow, USSR). p.539-42 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The helicity of cosmic μ mesons which had an appreciable degree of polarization was measured. The meson energy ranged from 3 to 6.5 Bev. A value of $+0.38 \pm 0.15$ was obtained for the polarization. The sign (+) denotes the left-handed helicity of μ^+ mesons and the right-handed helicity of μ^- mesons. (M.C.G.)

9889 A DETERMINATION OF THE LIFETIME OF THE μ^+ MESON. A. Astbury, P. M. Hattersley, M. Hussain, A. Kemp, and H. Muirhead (Univ. of Liverpool, England). p.542-4 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The lifetime of μ^+ mesons was measured by stopping positive pions in a sulfur target and detecting the electrons from the decay sequence $\pi^+ \rightarrow \mu^+ \rightarrow e$. A value of 2.225 ± 0.006 μsec was obtained for the lifetime. (M.C.G.)

9890 HIGH ENERGY GAMMA-RAYS FROM MUON CAPTURE. J. W. Keuffel (Univ. of Utah, Salt Lake City). p.544-7 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An energetic delayed non-ionizing radiation associated with muons stopping in a thin target was observed. The effect was tentatively ascribed to previously unobserved high-energy γ radiation associated with muon capture in copper, iron, and zinc. The effect was found to be a sensitive, but smoothly varying, function of atomic weight. (M.C.G.)

9891 ON THE INTENSITY OF RADIATIONLESS TRANSITIONS IN THE μ-MESIC ATOMS OF Pb, Bi, Th, U^{235}, U^{238}. A. I. Mukhin, M. J. Balatz, L. N. Kondratiev, L. G. Landsberg, P. I. Lebedev, Yu. V. Obukhov, and B. Pontecorvo (Joint Inst. for Nuclear Research, Dubna, USSR). p.550-2 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An investigation was made of the intensities of the $2P \rightarrow 1S$ transitions in the mesic atoms of Pb, Bi, Th, U^{235}, and U^{238}. The background from other transitions was studied in separate experiments. The mesic x-ray spectra were determined. (M.C.G.)

9892 THE ρ-VALUE FOR THE β-DECAY OF THE NEGATIVE MUON. M. M. Block, E. Fiorini, and T. Kikuchi (Duke Univ., Durham, N. C.), G. Giacomelli, and S. Ratti. p.553-6 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Meson (μ^-) decays were examined in order to determine a value for the Michel parameter ρ. The momentum distribution was determined. The best value of ρ was obtained by comparing the experimental distribution with theoretical spectra corresponding to different values of ρ, using the method of minimum x^2. A value of 0.764 ± 0.032 was obtained for ρ, in excellent agreement with the two-component neutrino hypothesis of Lee and Yang. (M.C.G.)

9893 ELECTROMAGNETIC PROPERTIES OF A CHARGED VECTOR MESON INTERMEDIARY IN WEAK INTERACTIONS. S. A. Bludman and J. A. Young (Lawrence Radiation Lab., Univ. of California, Berkeley). p.564-6 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

It is shown that the argument against the presence of the β meson, which involves the unobserved process $\mu \rightarrow e + \gamma$, depends on the electromagnetic interaction of the process. An experiment alternative to the neutrino experiments is proposed to detect the intermediary boson if it exists. This experiment would involve photoproduction in the field of a nucleus. (M.C.G.)

9894 INTERMEDIATE BOSON HYPOTHESIS OF WEAK INTERACTIONS. T. D. Lee (Inst. for Advanced Study,

Princeton, N. J.). p.567-72 of "Proceedings of the 1960 International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Various theoretical and experimental consequences of the intermediate boson hypothesis of weak interactions are discussed. The hypothesis that all weak interactions are transmitted through a single type of boson field, W, was investigated. The schizon interaction scheme for W particles is given. (M.C.G.)

9895 ON HIGH ENERGY NEUTRINO PHYSICS. M. A. Markov (Joint Inst. for Nuclear Research, Dubna, USSR). p.578-81 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Analyses showed that it is possible to carry on neutrino experiments with existing accelerations and underground, with cosmic neutrinos. Photon fluxes in proton accelerators were estimated and it was found that photoproduction of intermediate vector mesons is feasible. The cross section for the process $\nu + \mathcal{Z} \rightarrow \mathcal{Z} + e^+ + e^- + \nu$, when $\mathcal{Z} = 80$, was found to be approximately $7 \times 10^{-40} \times E_\nu^2$ cm^2. A comparison is presented of the frequency of neutrino events in accelerators and in cosmic radiation. (M.C.G.)

9896 THE PROGRAM OF "NEUTRINO EXPERIMENTS" AT CERN. G. Bernardini (CERN, Geneva, Switzerland). p.581-5 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The use of high-energy neutrinos produced in the decay in flight of mesons (π) as a probe to investigate weak interactions is discussed. The total cross section in the low-energy limit was found to vanish as E_ν^2 and at high energies tended to a constant limit. The maximum value obtained for the total cross section was 10^{-38} cm^2. It was found that the number of neutrino interactions is approximately 2 per ton per day, but detectors of 5 to 10 tons appeared possible. The background around the Proton Synchrotron at CERN was investigated. (M.C.G.)

9897 CONSISTENCY BETWEEN THE $\Delta T = \frac{1}{2}$ RULE AND THE LOW RATE OF $K^+ \rightarrow \pi^+ + \pi^0 + \gamma$ AS COMPARED TO $K^+ \rightarrow \pi^+ + \pi^0$. R. Gatto (Laboratori Nazionale di Frascati, Frascati, Italy). p.586-8 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Calculations which show no inconsistency between the present data on $K^+ \rightarrow \pi^+ + \pi^0 + \gamma$ and the $\Delta T = \frac{1}{2}$ rule for strange particle decay are given. Good's explanation that the present data on the reaction may well be resolved by assuming the process to be due to internal bremsstrahlung during the decay $K^+ \rightarrow \pi^+ + \pi^0$ is discussed. A model in which $K \rightarrow 2\pi$ proceeds through virtual dissociation of the K meson into a nucleon and hyperon and the hyperon decay interaction is proportional to the derivative of the pion field is considered. (M.C.G.)

9898 $\Delta S = 1$, $\Delta I = \frac{1}{2}$ RULES WITH CHARGED INTERMEDIATE BOSONS ONLY. B d'Espagnat (Service de Physique Théorique, Orsay, France). p.589-90 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

As an alternative to the schizon scheme of Lee and Yang, a theory of weak interactions which gives $\Delta I = \frac{1}{2}$ and $|\Delta S| = 1$ without involving any charge retention current is proposed. Three requirements were assumed for this theory: no $|\Delta S| = 2$ in nonleptonic modes, $|\Delta I = \frac{1}{2}$, and that no neutral intermediate boson exists. (M.C.G.)

9899 ASYMMETRY IN THE PIONIC DECAY OF Λ AND Σ HYPERONS. J. W. Cronin (Princeton Univ., N. J.). p.590-4 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A search was made for asymmetries in the pionic decay modes of Λ^0 and $\Sigma^\pm$ hyperons. An asymmetry $\alpha\overline{P} = 0.70 \pm 0.30$ was found for $\Sigma^+ \rightarrow \pi^0 + P$. For Λ^0 decay, a value of 0.55 ± 0.06 was obtained for $(\alpha^-)_\Lambda \overline{P}$. The ratio $(\alpha^0)_\Lambda/(\alpha^-)_\Lambda$ was determined as 1.10 ± 0.27. For Σ^- hyperons, $(\alpha^-)_\Sigma \overline{P}$ was found to be 0.01 ± 0.17. The results were compelling arguments for the validity of the $|\Delta I| = \frac{1}{2}$ rule. (M.C.G.)

9900 MEASUREMENT OF THE BRANCHING RATIOS OF K_1^0 AND Λ^0. C. Baglin, M. Bloch, et al. (Ecole Polytechnique, Paris, France). p.594-5 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The branching ratios of K_1^0 and Λ^0 were measured by direct observation of the γ's in a bubble chamber containing propane and methyl iodide. The event analyzed came from the reactions $\pi^- + p \rightarrow \Lambda^0 + K^0$ and $\pi + p \rightarrow \Sigma^0 + K^0$. The results obtained are: $B_{K_1^0} = 0.26 \pm 0.06$ and $B_\Lambda = 0.28 \pm 0.08$. (M.C.G.)

9901 LIFETIME ESTIMATES FOR THE HYPERNUCLEI $_\lambda H^4$, $_\lambda He^4$ AND $_\lambda H^3$. M. Bloch, E. Brucker, et al. p.595-6 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Hyperfragment formation was observed in a helium bubble chamber exposed to a K^- meson beam. A maximum likelihood calculation for the lifetime of the $_\lambda He^4$ hypernuclei, based on the ranges of 19 events, gave a most probable lifetime = ∞, but the value of τ one standard deviation away was 1.4×10^{-10} sec. A value of $1.53^{+4.0}_{-0.5} \times 10^{-10}$ sec was obtained for the lifetime of $_\lambda H^4$. For $_\lambda H^3$ the lifetime was determined as 1.8×10^{-10} sec. (M.C.G.)

9902 THE K_1^0-K_2^0 MASS DIFFERENCE. R. W. Birge, R. P. Ely, W. M. Powell, et al. (Lawrence Radiation Laboratory, Univ. of California, Berkeley). p.601-2 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An experiment designed to measure the K_1^0-K_2^0 mass difference is described. Bubble chamber pictures were scanned for events in which the K^+ meson underwent charge exchange $K^+ + n \rightarrow K^0 + p$ and in which the K^0 component of the original K^0 beam subsequently interacted with the propane. The momentum of the interacting K^0 was determined. The relative likelihood of various mass difference values was calculated. A value of 1.5 appeared the most likely. (M.C.G.)

9903 ON THE DECAY PROPERTIES OF K_2^0 MESONS. D. Neagu, E. O. Okonov, N. I. Petrov, et al. (Joint Inst. for Nuclear Research, Dubna, USSR). p.603-4 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

After exposing a magnet cloud chamber to a beam of K_2^0

particles, 500 events interpreted as decays were recorded. The relative rate of K_{e3}^0 decay and the charge ratio in three-body decays were estimated. It was found that the fraction of K_{e3}^0 decay with respect to all charged decay modes is 38%. No $K_2^0 \rightarrow \pi + \pi$ decay was found. Three $K_2^0 \rightarrow \pi^+ + \pi^- + \pi^0$ events were observed. Analysis of all the events is not complete. (M.C.G.)

9904 ON THE e-μ RELATIVE LEPTICITY. F. E. Prieto and J. de Oyarzabal (Univ. of Mexico, Mexico City.). p.606 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Two nonequivalent possibilities in agreement with the observed helicities in β, μ, and π decays, were found for the weak lepton current in the interaction hamiltonian. (M.C.G.)

9905 MESIC DECAY OF HYPERFRAGMENTS. S. Iwao and E. C. G. Sudarshan (Univ. of Rochester, Rochester, N. Y.). p.607-8 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An investigation was made of the charged mesic decay modes of hyperfragments. Antiparallel spin coupling was found to be favored in $p_{3/2}$-shell but not in $p_{1/2}$-shell hyperfragments. Antiparallel spin was favored in s-shell hyperfragments. (M.C.G.)

9906 POSSIBLE FORMAL SYMMETRY BETWEEN MUON AND ELECTRON. R. Gatto (Laboratori Nazionali di Frascati, Frascati, Italy). p.609-10 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

If weak interactions were excluded, a symmetry property of the Lagrangian related to μ-e exchange was found under the S transformation. No symmetric descriptions were found if electrons and muons were coupled identically in weak interactions and if only one neutrino exists. A conservation law which forbids a muon from transforming to an electron unless other particles with S quantum numbers are emitted or absorbed was developed. (M.C.G.)

9907 SHELL MODEL CALCULATIONS OF THE HYPERFINE SPLITTING EFFECT IN THE CAPTURE OF μ MESONS. H. Überall (Carnegie Inst. of Tech., Pittsburgh, Penna.). p.612-13 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Using the shell model to describe the capturing, the influence of the hyperfine interaction between meson (μ) and nuclear spin on the capture rate of μ mesons was investigated. Al^{27} and P^{31} were studied assuming a successive filling of the $(1d_{5/2})$, $(2s_{1/2})$, and $(1d_{3/2})$ shells. The numerical values of Primakoff's coupling constants were used. Values of $\Lambda\Lambda/\Lambda$ are given for Al^{27} and P^{31}. (M.C.G.)

9908 NEUTRAL DECAY MODES OF Λ^0 AND K^0. J. L. Brown, H. C. Bryant, et al. (Univ. of Michigan, Ann Arbor). p.613 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Evidence of the existence of the decay modes $\Lambda^0 \rightarrow n + \pi^0$ and $K^0 \rightarrow \pi^0 + \pi^0$ was obtained by exposing a 21-liter xenon bubble chamber to a meson (π^-) beam. Branching ratios, B_Λ and B_K, for the production of neutral particles were determined. Values of 0.35 ± 0.05 and 0.30 ± 0.04 were obtained for B_Λ and B_K, respectively. (M.C.G.)

9909 ANGULAR DISTRIBUTION OF THE $\mu^+ \rightarrow e^+$ DECAY ELECTRONS IN STRONG MAGNETIC FIELDS. B. A. Nikolsky and S. A. Ali-Zade (I. V. Kurchatov Inst. of Atomic Energy of the USSR Academy of Sciences, Moscow, U.S.S.R.). p.614-17 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The asymmetry parameter a of the angular distribution of the $\pi \rightarrow \mu \rightarrow e$ decay electrons was studied in magnetic fields with intensities up to 35,000 gauss. Since the μ meson is depolarized in coming to rest, the angular distribution of decay electrons determines the value $a^* = Pa$, where P is the degree of residual polarization of the meson which is stopped in a given moderator. A value of $\frac{1}{3}$ was obtained for a^* at field intensities of 20,000 to 30,000 gauss. A slight increase in a^* was observed with increases in field intensity and with dilution of the emulsion. Results indicated that a depolarization mechanism in addition to muonium formation must exist. (M.C.G.)

9910 EXPERIMENTS WITH NEUTRINOS EMITTED BY MESONS. B. Pontecorvo (Joint Inst. for Nuclear Research, Dubna, USSR). p.617-18 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The use of neutrinos emitted by mesons to obtain information on weak interactions is discussed. Experiments to determine the existence of an intermediate vector B meson, to decide whether muon and electron neutrinos are identical particles, and to measure the energy dependence of cross sections for weak processes are described. (M.C.G.)

9911 SCATTERING OF ELECTRONS BY PROTONS. K. Berkelman, J. M. Cassels, D. N. Olson, and R. R. Wilson (Cornell Univ., Ithaca, N. Y.). p.757-61 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The scattering of electrons by protons was studied using the electron beam of the Cornell 1.3-Bev synchrotron. Polyethylene and carbon targets were used. The recoil proton and scattered electron peaks observed at 66° from 781-Mev incident electrons are given. A plot was made of the positions of the peaks vs. the theoretical momenta of the particles being detected. The results suggested that the ratio of the experimentally determined cross section varies with scattering angle for higher values of the square of the 4-momentum transfer. (M.C.G.)

9912 SPLITTING OF THE PROTON FORM FACTORS AND DIFFRACTION IN THE PROTON. R. Hofstadter, F. Bumiller and M. Croissiaux (Stanford Univ., California). p.762-6 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The two-proton form factors were successfully split apart in proton-electron scattering experiments. Incident electrons with energies of 600 to 900 Mev were used. Cross sections and values of the square of the momentum transfer, q^2, were determined. The separate form factors were solved by choosing a pair of experimentally measured cross sections at the same value of q^2 but at different

correlated values of energy and angle. The method of intersecting ellipses was used. A diffraction dip was found in the cross section data. The form factor F_2 appeared to approach 0 at higher values of q^2, whereas F_1 became constant. (M.C.G.)

9913 SOME SPECULATIVE REMARKS ON THE DIRAC AND PAULI FORM FACTORS OF THE NEUTRON. R. Herman (Research Lab., General Motors Corp., Warren, Mich.) and R. Hofstadter. p.767-8 of "Proceedings of the 1960 International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The recent determination of split form factors of the proton suggested the possibility of determining an $F_{1n} \pm 0$ for the neutron. It was assumed that F_{2n} of the neutron is approximately equal to F_{2p} of the proton. Then using the Rosenbluth formula for the neutron, F_{1n} was determined. Isotopic form factors were also evaluated. (M.C.G.)

9914 PROGRESS REPORT ON e-e COLLIDING BEAMS EXPERIMENT. W. K. H. Panofsky (Stanford Univ., California). p.769-70 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A brief description of the electron colliding beam experiment is given. An arrangement of the apparatus is shown. Three bending magnets will be used to inject the electron beam into either of two intersecting rings. The two beams will be made to cross at the intersecting part of the magnets by means of two magnetic fields parallel to the plane of the orbit. (M.C.G.)

9915 e-e COLLIDING BEAM EXPERIMENT (THEORETICAL). Yung-Su Tsai (Stanford Univ., California). p.771-4 of "Proceedings of the 1960 Annual Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The angular distributions and cross sections in the electron-electron colliding beam experiment were investigated in order to determine the validity of quantum electrodynamics at small distances. Two possible sources of breakdown of quantum electrodynamics are discussed: an electron may not be a point particle but may have some kind of charge distribution and Coulomb's law may not hold at small distances. The angular dependence of radiative corrections to the cross sections was determined. It was found that the vacuum polarization effect is small except when the loop is an electron pair. (M.C.G.)

9916 ELECTROMAGNETIC STRUCTURE OF THE PION. G. F. Chew (Lawrence Radiation Lab., Univ. of California, Berkeley). p.775-8 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The meson (π)-photon vertex is discussed as a function of the mass of the proton. This quantity could be measured in electron-pion elastic scattering or in the production of a pion pair by electron-positron annihilation. Calculations of the low-energy resonance in this production predicted a very high and sharp peak. On the basis of nucleon structure, a 3-π resonance of comparable strength with the 2-π state is expected. (M.C.G.)

9917 THE ANOMALOUS MAGNETIC MOMENT OF THE MUON. G. Charpak, F. J. M. Farley, et al. (CERN, Geneva, Switzerland). p.778-85 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A method of determining whether the meson (μ) g factor is exactly as predicted by quantum electrodynamics is described. The meson (μ) magnetic moment anomaly (g-2)/2, which arises from interaction with photons of energy comparable to the meson (μ) rest mass, was determined by indirect methods, involving accurate measurement of the rest mass, to be approximately 2. The similarity of spin and orbit motion for particles with g-2 in static magnetic fields was used to measure directly the deviation of g from 2. This experiment gave a value of 1.8 ± 0.3 for g. The result was completely inconsistent statistically, with the quantum electrodynamics value of the anomaly. (M.C.G.)

9918 GYROMAGNETIC RATIO OF FREE PROTONS AT 150 MeV. B. Rose (Atomic Energy Research Establishment, Harwell, Didcot, England). p.787-8 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The gyromagnetic ratio, ω_S/ω_L, of free protons was determined by passing a horizontally and transversely polarized proton beam at 150 Mev through a bending magnet with a vertical magnetic field. The solenoid asymmetry was measured as a function of the total deflection angle of the proton beam. The angle at which the asymmetry vanished was determined. A value of 3.076 ± 0.008 was obtained for ω_S/ω_L. The electric dipole moment was found to be 0.08 ± 0.04. (M.C.G.)

9919 EXPERIMENTAL LIMITS FOR THE ELECTRON-PROTON CHARGE DIFFERENCE AND FOR THE NEUTRON CHARGE. J. C. Zorn, G. E. Chamberlain, and V. W. Hughes (Yale Univ., New Haven, Conn.). p.790-2 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Upper limits to the charges of cesium and potassium atoms were established by observing the deflection of an atomic beam in a homogeneous electric field. The results obtained are $|q(Cs)| \leq 4.8 \times 10^{-17}\ q_e$ and $q(K) \leq 9.6 \times 10^{-17}\ q_e$, where q_e is the value of the electron charge. An upper limit of $3.6 \times 10^{-19}\ q_e$ was found for the electron-proton charge difference and $1.6 \times 10^{-17}\ q_e$ was obtained for the neutron charge. (M.C.G.)

9920 HIGH ENERGY MUON SCATTERING. D. Heggie, Y. Kim, G. Masek, and R. Williams (Univ. of Washington, Seattle). p.793-5 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An experiment designed to measure the large momentum-transfer single-scattering cross section of a muon beam of known purity and incident energy is described. The integral scattering distribution in carbon and lead was determined. The experimental upper limit obtained for the anomalous cross section was 10^{-29} cm^2/sterad per nucleon. The experiments gave no evidence of an anomaly in μ meson scattering. (M.C.G.)

9921 ELASTIC SCATTERING OF μ^+ IN NUCLEAR EMULSION. P. Connolly, J. G. McEwen, and J. Orear (Cornell Univ., Ithaca, N. Y.). p.796 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The cross sections were measured for the elastic scattering of mesons (μ^+) on AgBr in nuclear emulsions for momentum transfers of up to 160 Mev/C. Data indicated that the μ^+ meson behaves the same as a position, but with a mass 207 times larger. (M.C.G.)

9922 PROGRESS REPORT ON WORK WITH THE 25 GeV PROTON SYNCHROTRON. G. Cocconi (CERN, Geneva, Switzerland). p.799-808 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The information gathered about the energy spectra and angular distributions of the secondary particles produced in an aluminum target by the 25-Bev internal proton beam of the CERN synchrotron is reviewed. Experimental results were compared with calculations performed by Hagedorn utilizing the Fermi model. The total multiplicity of charged particles in p-p interactions at 25 Bev was measured. The energy spectra of photons and mesons (π^-) produced by protons on aluminum, deuteron production on various targets, He^3 and H^3 production, absorption cross sections for protons on various elements, and data on neutrino interactions are given. Angular distributions and cross sections were determined for meson (K), meson (π), proton, and antiproton interactions with protons. (M.C.G.)

9923 PARTICLES PRODUCED BY 24 BeV PROTONS. L. Gilly, B. Leontic, A. Lundby, R. Meunier, J. P. Stroot, and M. Szeptycka (CERN, Geneva, Switzerland). p.808-9 of "Proceedings of the 1960 International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The mass spectrum of long-lived ($\geq 10^{-8}$ sec) charged particles produced in the forward direction by 24-Bev protons striking an internal aluminum target was measured. The mass was determined by measuring momentum and velocity. At 1.5 Bev/c about 10% of the beam was K^+ mesons, at 3 Bev/c about 0.2% $\bar{p}$, at 6 Bev/c about 0.5% d, and at 9 Bev/c about 10^{-4}% H^3 and He^3. (M.C.G.)

9924 REMARKS ON HIGH ENERGY INTERACTIONS. V. I. Veksler (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). p.810-11 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

In all collisions of pions with nucleons, nucleons with nucleons, and the production of strange particles by pions on protons, a very characteristic continuation of the backward motion of the particle which had the nuclear charge was observed. In all three types of collisions the mean transverse momenta were practically the same and equal to 300 to 400 Mev/c. Other interactions showing the same characteristics led to the assumption that all cases were peripheral collisions. Possible diagrams for these reactions are given. (M.C.G.)

9925 STATUS REPORT OF INTERNATIONAL COOPERATIVE EMULSION FLIGHT PROJECT ON HIGH ENERGIES. M. Koshiba (Univ. of Chicago, Ill.). p. 812-15 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

An International Cooperative Emulsion Flight Project to study high energy jets in photographic emulsion is described. One 80-liter stack was exposed in the Caribbean in January 1960. The merit of exposure was about 120 liter-hr. The exposed stack was processed successfully and distributed among the collaborating laboratories. Preliminary results from one laboratory are reported for two events. In the first, a minimum ionizing particle made a jet and after 1.1 mm one of the charged secondaries made another jet of higher multiplicity. This event illustrated the failure of the angular distribution method for primary energy estimation. In the other event, a minimum ionizing particle produced a narrow fork of three charged secondaries which apparently did not interact for more than 120 cm in the emulsion. (M.C.G.)

9926 ANGULAR DISTRIBUTION OF HIGH ENERGY JETS. J. Gierula (Univ. of Chicago, Ill.). p.816-18 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Angular distributions of multiple meson production in nuclear collisions in emulsions at energies above 10^{12} ev were investigated. A two-center model that predicts angular distributions which have either one or two maxima when plotted in log (tan θ_L) coordinates (where θ_L is the production angle) was used for the calculations. The pronounced effect of the double maximum for jets with small mulitplicity suggested that the maximum distribution is connected with N-N collisions. However, a very significant double maximum was also observed for jets having more than 8 evaporation tracks. These jets were generated in collisions with heavy-emulsion nuclei. (M.C.G.)

9927 ON THE ANGULAR DISTRIBUTION OF SHOWER PARTICLES ACCORDING TO THE EXCITED NUCLEON MODEL OF MESON PRODUCTION. G. Yekutieli and U. Maor (Weizmann Inst. of Sciences, Rehovoth, Israel). p.818-19 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Angular distributions of mesons in N-N and N-nucleus collisions were investigated according to the excited nucleon model of meson production. The results of this model were evaluated by a Monte Carlo calculation. (M.C.G.)

9928 STUDY OF NUCLEON-NUCLEON INTERACTIONS AT HUNDREDS OF BeV. N. A. Dobrotin and S. A. Slavatinsky (P. N. Lebedev Physical Inst. of Academy of Sciences, Moscow, U.S.S.R.). p.819-28 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Nucleon interactions with nucleons were studied in a 70-liter cloud chamber placed in a magnetic field of 6000 oersteds. Lithium hydrate was used as a target. The primary particle energy was determined by a calorimetric technique from the total energy release. The energies of the primaries, most of which were nucleons, clustered around a value of 300 Bev. The average number of charged shower particles per one shower at this energy was found to be 8 ± 1. The inelasticity coefficient was determined directly from the curvature measurements of the secondary particle tracks in a magnetic field and found to equal 0.3. Results indicated that in the center-of-mass system the greater part of the showers produced in N-N collisions at this high energy was characterized by a sharp asymmetry. The type of shower symmetry was found to be closely related to the inelasticity coefficient values which describe the given collision of two nucleons. On the basis of results, the N-N interactions were divided into three types: peripheral, central, and central-pheripheral collisions. (M.C.G.)

9929 γ-RAYS FROM VERY HIGH ENERGY INTERACTIONS. H. Ali, J. Duthie, et al. (Univ. of Bristol, England). p.829-35 of "Proceedings of the 1960 Annual Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Emulsion-heavy metal sandwich stacks were used to study high-energy nuclear disintegrations and γ rays. The stacks were exposed on Comet aircraft for approximately 2000 hr. About 3000 cascades were detected of which roughly one-half were produced by nuclear interactions within the assembly. The other half resulted from the incidence of a γ ray or electron on the stack. The energy spectrum of the two classes of cascades was determined. The relative efficiency with which various elementary particles transformed into μ and γ beams is given. An "elbow" was observed at about 4000 Bev in the spectrum of the cascade due to nuclear interactions in the stack. Six examples of nuclear interactions where more than 50,000 Bev was given to the soft cascade are discussed. In one of these, 600 particles were created. (M.C.G.)

9930 PARTICLE ABUNDANCES IN INTERACTIONS WITH 25 GeV PROTONS. G. von Dardel, R. M. Mermod, G. Weber, and K. Winter (CERN, Geneva, Switzerland). p.837-9 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The 25-Bev internal proton beam of the CERN synchrotron was made to interact with a thin aluminum flip target. Measurements of particle abundance were made on the secondary beams leaving the synchrotron at angles of 3 and 6° with respect to the internal beam. The measured proton-pion ratio indicated a large excess of protons above 14 Bev/c and a smaller deficiency of protons below this energy. The measured K^+/π^+ ratio was 0.2 to 0.3 in the range of 5 to 18 Bev/c. The K^-/π^- ratio was measured as 0.066 ± 0.020 at 5 Bev/c, 0.54 ± 0.007 at 6 Bev/c, and 0.039 ± 0.007 at 8 Bev/c. The K^+/K^- ratios of 3 to 5 were measured between 5 and 8 Bev/c. The antiproton to pion ratio was measured as 0.014 ± 0.002 at 6 Bev/c, 0.007 ± 0.008 at 8 Bev/c, 0.0028 ± 0.0006 at 11 Bev/c, and 0.0028 ± 0.001 at 16 Bev/c. The d/π^+ ratio was 0.05 at 18 Bev/c. (M.C.G.)

9931 PION CLOUD EFFECTS IN HIGH ENERGY MESON PRODUCTION. E. Friedlander (Inst. of Atomic Physics, Bucharest, Rumania). p.840 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

High-energy nuclear collisions were recorded in five emulsion stacks. Angular distributions were analyzed and individual estimates for the Lorentz factor were obtained. The spectra yielded the range of effective target masses and proved the occurrence of collisions involving individual pions in the meson clouds of the collision partners. Individual dispersions estimated for the showers demonstrated the occurrence of significantly nonisotropic angular distributions with a bimodal slope typical for two-center jets. The expected and observed values of the ratio of laboratory frame Lorentz factors of the two centers were in good agreement. (M.C.G.)

9932 COMPOSITE MODEL OF ELEMENTARY PARTICLES. Y. Ohnuki (Nagoya Univ., Japan). p.843-51 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The composite model proposed by Sakata for particles belonging to the baryon-meson family is discussed. According to it, protons, neutrons, and hyperons (Λ) are regarded as basic particles and others belonging to this family are assumed to be compound objects constructed out of these three. The problems presented by this model include the kinematical aspect of the model and the dynamics appropriate to the composite state. Properties of the basic baryons assumed by this model are masses of the same order of magnitude, spin = $\frac{1}{2}$, and strong interactions which satisfy conservation laws $\Delta N_p = \Delta N_n = \Delta N_\Lambda = 0$, where ΔN is the change in number due to interaction. The compound states of these baryons were investigated to see to what extent the similarities hold. (M.C.G.)

9933 RECENT RESEARCH ON THE NONLINEAR SPINOR THEORY OF ELEMENTARY PARTICLES. W. Heisenberg (Max-Planck-Institut für Physik und Astrophysik, Munich, Germany). p.851-8 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Research on the nonlinear spinor theory was carried out along three lines: indefinite metric in Hilbert space, group theory, and approximation methods for the calculation of eigenvalues. Starting from given symmetry groups, bilinear forms which are invariant under the given transformations were studied and the corresponding fundamental metric tensor constructed. The representation of scale transformation in a Hilbert space with indefinite metric is discussed. Conservation of parity and representation of strange particles according to the group theory were studied. The vacuum expectation value of the product of four field operators was investigated. (M.C.G.)

9934 DYNAMICAL THEORY OF ELEMENTARY PARTICLES SUGGESTED BY SUPERCONDUCTIVITY. Y. Nambu (Enrico Fermi Inst. for Nuclear Studies, Univ. of Chicago, Ill.). p.858-66 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A theory of elementary particles based on a mathematical analogy between the dynamics of relativistic particles and superconductors is proposed. A comparison was made of the Dirac equation for a nucleon and the Bogolubov-Valatin relation for an elementary excitation in a superconducting medium. According to this theory the mass of a particle is due to some attractive correlation between massless bare particles. The nature of the interaction of the bare nucleon field was determined. A Hartree-Fock procedure was set up for calculating the self-energy of a nucleon. Predictions of the theory for strong and weak interactions are discussed. (M.C.G.)

9935 NEW FUNCTIONAL METHODS IN FIELD THEORY. D. I. Blokhintsev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). p.867-71 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

Functional methods in the quantum field theory in which the perturbation theory is not applied are discussed. A new way of solving the equations of mesodynamics for models with a fixed source is described. An essential advantage of this new method consists in the possibility of writing an explicit expression for the nth order approximation. Because of this the convergence of the entire series can be investigated. The qualitative analysis of functional equations is also discussed. (M.C.G.)

9936 ON THE APPLICATION OF THE METHODS OF THE SUPERCONDUCTIVITY THEORY TO THE PROBLEM OF THE MASSES OF ELEMENTARY PARTICLES. V. G. Vaks and A. I. Larkin (Academy of Sciences of the U.S.S.R., Moscow). p.873 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A simple Lagrangian containing only a two-component spinor field was considered. The equation of motion was solved using the superconductivity theory. Both trivial and nontrivial solutions were obtained. It was found that CP odd excitations of zero mass and a CP even bound state of two particles exist in the system. (M.C.G.)

9937 THE ELECTRODYNAMICS OF A ZERO MASS SPINOR PARTICLE. V. G. Vaks (Academy of Sciences of the U.S.S.R., Moscow). p.874 of "Proceedings of the 1960 Annual Conference on the High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The electrodynamics of a two-component massless particle with charge e_1 is discussed. It was postulated from the quantum theory that electromagnetic radiation at any frequency will produce pairs in an external field. It was indicated from various considerations that $e_1/e \lesssim 10^{-8}$. (M.C.G.)

9938 AN EXAMPLE OF A FIELD THEORY WITH NONORTHODOX METRIC IN HILBERT SPACE. M. A. Markov (Joint Inst. for Nuclear Research, Dubna, USSR). p.874-5 of "Proceedings of the 1960 Annual Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

The regularizing masses of the field theory led to redundant particles and an indefinite or semi-definite metric of the corresponding Hilbert space. An attempt to construct a theory to explain this, in which time is an operator that does not commute with energy within the short times of collisions, is discussed. In this theory the particles behave like "wave packets" with nonorthodox metric. (M.C.G.)

9939 MASSES AND MEAN LIVES OF ELEMENTARY PARTICLES. W. H. Barkas and A. H. Rosenfeld (Univ. of California, Berkeley). p.877-9 of "Proceedings of the 1960 Annual International Conference on High Energy Physics at Rochester, The University of Rochester, Rochester, N. Y., August 25–September 1, 1960."

A table containing a compilation of information on the masses and mean lives of elementary particles available from both published and unpublished sources is given. It was assumed that the particle and antiparticle shared the same spins, masses, and mean lives. (M.C.G.)

Neutron Physics

9940 (AERE-R-3400) THE CALCULATION OF THERMAL NEUTRON SPECTRA BY PERTURBATION THEORY. P. Schofield (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). August 1960. 18p.

A method of treating neutron thermalization problems by perturbation theory is discussed. This involves using the eigenfunctions of the scattering kernel for the moderator. Two simple examples are considered: the time-decay of a pulse of neutrons in a block of moderating material and the spectrum in an infinite homogeneous medium. In the case of moderation by a monatomic gas, analytical solutions are obtained using Laguerre polynomials. Extension of the method to more complex problems is discussed. (auth)

9941 (ARF-1164-9) RESEARCH STUDY ON NEUTRON INTERACTIONS IN MATTER AS RELATED TO IMAGE FORMATION. Third Technical Report for Period Covered, November 1, 1960–December 31, 1960. H. V. Watts (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Jan. 9, 1961. 20p. Contract AT(11-1)-578.

Neutron imaging was studied in the thermal energy region where cross-section differences between elements are high, but where neutron scattering constitutes a major part of the total cross section. The preparation of an optical spot diagram for use in the image synthesis technique is described. The spot diagram is obtained from the neutron scattering point spread function and is a basic parameter in the neutron to optical analog conversion. Optical experiments with the spot diagram, which represents the case of a scatterer of six mean free path thickness, are beginning. A multiple wire spark counter with a boron (n,α) neutron converter was operated in the collimated neutron beam. The speed of this system is about 40 times faster than the maximum speed of the indium activation foil-transfer technique, but an image distortion is seen, presumably caused by a dependence of α counting efficiency on the particle track orientation. Neutron beam measurements with indium and gold activation foils, with and without cadmium filters, indicated that the neutron beam is more energetic than a true thermal neutron distribution. Several gold-silicon barrier semiconductor particle detectors are being tested as neutron detectors. (For preceding period see ARF-1164-6). (auth)

9942 (CF-60-11-67) EQUIPOISE-2: A TWO-DIMENSIONAL, TWO-GROUP, NEUTRON-DIFFUSION CODE FOR THE IBM-7090 COMPUTER. T. B. Fowler and Melvin Tobias (Oak Ridge National Lab., Tenn.). Nov. 21, 1960. 6p.

EQUIPOISE-2, a two-dimensional two-group neutron-diffusion code in R-Z geometry, was programmed for the IBM-7090 computer. The code was designed to permit the running of large numbers of cases without requiring excessive machine time. Typical running times are of the order of 1 to 3 min per case for a 1000-point problem. The maximum number of mesh points that can be used is 1444. FORTRAN II is the source language for the code. It is programmed to run under the IBM-7090 FORTRAN Monitor System and takes advantage of the CHAIN feature of that system. (auth)

9943 (IDO-16612) AN INTEGRAL METHOD FOR IDENTIFYING NEUTRON FLUX SPECTRA. R. G. Nisle (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Dec. 2, 1960. 90p. Contract AT(10-1)-205.

A means for identifying an unknown flux spectrum by experimental means in terms of a few characteristic parameters is described. The three parameters that were chosen are nv_0, the "conventional flux" of Westcott; $T(E_T = kT)$, the neutron temperature that is characteristic of a Maxwellian distribution; and F_1, the factor that characterizes the 1/E component of the distribution function. A fourth parameter, μ, characterizes the transition component and is found to vary only slightly for a large class of light-water-moderated reactors. The method of measuring these parameters is based on Gavin's method for the measurement of neutron temperature. The method is extended to include the measurement of F_1 and broadened by integrating it with an effective cross section index convention. Thus the identification of an unknown neutron flux spectrum and an effective

cross section index convention become combined to form a unified system. (auth)

9944 (IEA-10) A DIFFUSÃO DE NEUTRONS EM MEIOS MODERADORES E MULTIPLICADORES COM UMA FONTE PERIÓDICA DE NEUTRONS-NOTA PREVIA. (Diffusion of Neutrons in Moderating and Multiplying Media with a Periodic Neutron Source). Gerhard Jacob (Brazil. Instituto de Energia Atômica, São Paulo). 1960. 8p.

The symbolic method of calculation developed by Gallone, Orsoni, and Salvetti is applied to the study of the spacial and temporal distribution of thermal neutrons in moderating and multiplying media with a fast neutron source with its intensity oscillating with time. The general case of a periodic fast neutron point source is considered using a Fourier analysis. The study then includes the special cases of triangular-shaped pulses of fast neutrons produced from sinoidal and rectangular ones, in spherical, cylindrical, and parallelepiped multiplying and moderating media. (tr-auth)

9945 (KAPL-M-JA-10) EQUATIONS FOR THE FICS ROUTINE OF THE KARE SYSTEM. J. A. Archibald, Jr. and G. L. Johns (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 12, 1960. 79p. Contract W-31-109-Eng-52.

Equations for the FICS routine, (of the KARE system), a method of calculating cross sections, are given. The calculation of thermal and epithermal cross sections is independent. Age factors and effective neutron temperatures as used in WOXX do not occur. In burn-up calculations, the only burnable fuel allowed is U^{235} and the only burnable poison is B^{10}. All other substances are treated as structures and ignored in the burn-up calculations. (C.J.G.)

9946 (NAA-SR-Memo-5546) NEUTRON AGE MEASUREMENTS IN WATER, D_2O, WATER-METAL MIXTURES, GRAPHITE, VARIOUS ORGANICS AND ORGANIC-METAL MIXTURES AND SLOWING DOWN PROPERTIES OF VARIOUS MEDIA FOR NEUTRONS. UNCLASSIFIED BIBLIOGRAPHY. Marianne J. Chapman (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 1, 1960. 15p.

This bibliography contains 175 references on neutron age measurements. The references are arranged in the following sections: books; reports; Geneva conference reports; and journal articles. The sources used in the compilation are Applied Science and Technology Index, 1958-1960; ASTIA Documents Unclassified Subject Index; Chemical Abstracts, 1950-1957; First and Second International Conferences on Peaceful Uses for Atomic Energy (Geneva); Industrial Arts Index, 1951-1957; Monthly Catalog of Government Publications, 1952-1960; Nuclear Science Abstracts, 1950-1960; Science Abstracts, Section A, Physics, 1950-1960; and U. S. Government Research Reports, 1957-1960. (C.W.H.)

9947 (NAA-SR-Memo-5655) MONTE CARLO CALCULATION OF THE SLOWING DOWN MOMENTS IN HYDROCARBONS. H. Alter, J. Dudek, and G. Joanou (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 12, 1960. 16p.

Moments of the slowing-down density distribution in water, diphenyl, and graphite were determined by a Monte Carlo calculation. Specifically, the second, fourth, and sixth moments of the slowing-down density distribution are calculated, with the neutron slowing-down age defined as $1/6$ the second slowing-down moment. (W.L.H.)

9948 (TID-11026) COGENT. A One-Dimensional Multigroup Code for the Calculation of Neutron Space-Energy Distributions. R. L. Ellis, R. B. Kellogg, and B. J. McGovern (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). July 20, 1960. 29p. (MPC-18).

The COGENT code solves the one-dimensional neutron diffusion equation for 30 coupled energy groups with an external neutron source. The code will handle slab, cylindrical, or spherical geometry. COGENT provides for a maximum of ten isotopes and six scattering matrices. The external source may be specified region-wise constant, group-wise constant, region-wise by group, or point-wise by group. As output, in addition to the point-wise fluxes, the code provides flux weighted macroscopic constants. Problems are limited to a maximum of 101 spatial mesh points and 4 material regions. A 16K 704 with 5 tape units and 1 drum unit is required. An average problem requires approximately 40 min. (auth)

9949 (TID-11064) INTEGRAL NEUTRON THERMALIZATION. Monthly Progress Report for March, 1960. J. R. Beyster, W. M. Lopez, and R. E. Nather (General Atomic Div., General Dynamics Corp., San Diego, Calif.). May 18, 1960. 15p. Project 48.01, Contract AT(04-3)-167, Project Agreement No. 2.

The modification and installation of the new General Atomic L-Band Linear Accelerator is reported. Neutron spectra were remeasured by a pulsed-beam time-of-flight technique in water solutions poisoned by $CdSO_4$. Below 0.004 ev more reliability was obtained. The poisoned $ZrH_{1.8}$ spectrum was also measured. The study of the characteristics of neutron detectors under pulsed conditions continued. The neutron spectrum in poisoned graphite was measured; disagreements with theory are apparent at 0.1 ev, but which is in error is not known. An improvement in the slow chopper rotor, consisting of a new rotor of borated plastic, is discussed. Investigation of perturbation effects of the fission counter used on die-away experiments was carried out. Consideration was given to acquiring a small data-processing computer for the linear accelerator group. (T.R.H.)

9950 TIME VARIATION OF THE SPACE AND ENERGY DISTRIBUTIONS OF THE NEUTRONS FROM A PULSED SOURCE. I. G. Dyad'kin and E. P. Batalina. Atomnaya Energ. 10, 5-12(Jan. 1961). (In Russian)

The time dependence of spatial and energy distributions of neutrons from a pulsed source was analyzed. It was found that the time distribution of neutrons with a given energy complies with Poisson distribution probabilities. A spatial-energy-time relation, which indicates an independence of space-energy and time at certain distances and time intervals, was also found. A certain correlation between the two relations exists beyond a given interval and should be considered. The relation of the mean square of attenuating length to time was also derived. All relations are expressed by simple formulas. (tr-auth)

9951 BOUNDARY CONDITIONS IN THE SPHERICAL-HARMONICS METHOD. G. Ya. Rumyantsev. Atomnaya Energ. 10: 26-34(Jan. 1961). (In Russian)

Equations are developed for applying spherical harmonics to the single-velocity kinetic equation. The equations describe the conditions at the interface of two heterogeneous dispersing media. It is shown that the boundary conditions determine the solution for any arbitrary order of approximation (the so called p_N approximation). The application of even-order approximations is of great practical interest. For example, a not too cumbersome P_2 approximation can serve to verify the elementary theory of diffusion. Until now, even-order approximations were not utilized in calculations. (tr-auth)

9952 STOCHASTIC STUDY OF THE DISTRIBUTION OF NEUTRONS IN A MODERATOR. II. G. Louchard (Univ. Libre, Brussels). Bull. classe sci., Acad. roy. Belg., 46: 363-84(1960). (In French)

The energy distribution is considered with the use of characteristic functionals. In the absence of fission, this method permits previous results to be obtained more readily. Differential equations are obtained for the case of fission. The model is extended to the energeticospatial distribution. (auth)

9953 SAMPLE-HOLDER CORRECTIONS IN NEUTRON DIFFRACTION. F. Boutron and P. Mériel (Centre d'Études Nucléaires, Saclay, France). Bull. soc. franç. minérol. et crist., 83: 125-7(1960). (CEA-1526). (In French)

The theoretical rates of intensities of a neutron diffraction peak given by a cylindrical, thin-walled, transparent sample-holder, first filled with an absorbent, then empty, are evaluated. The experimental values fit the theoretical ones. (auth)

9954 TURBULENT DIFFUSION IN TWO AND THREE DIMENSIONS BY THE RANDOM-WALK MODEL WITH MEMORY. R. C. Bourret (Hughes Aircraft Co., Malibu, Calif.). Can. J. Phys., 39: 133-40(Jan. 1961).

A lattice model used for the derivation of the telegraph equation for diffusion is extended to two and three dimensions. Appropriate generalizations of the telegraph equation are obtained. These equations give a fine-grained chronological description of diffusion. From these equations the velocity autocorrelation functions of the diffusing particles are obtained. (auth)

9955 DETERMINATION OF THE DIFFUSION PARAMETERS OF THERMAL NEUTRON BY IMPULSE MEASUREMENTS. László Bod (Central Physical Research Inst., Hungary). Energia és Atomtech., 13: 506-9(1960). (In Hungarian)

The diffusion parameters such as the diffusion constant, absorption cross section, diffusion length, and transport mean free path of proposed moderater materials were determined formerly with the help of a Po-Be neutron source using stationary methods. According to the better impulse type measurement introduced during the past few years, a few μsec wide fast neutron beams from a pulsed neutron source are sent into the moderator material studied. After being slowed down and reaching a thermal equilibrium with the nuclei of the material, the neutron density, which is a function of capture and leakage processes, is determined by means of a multichannel analyzer. Results obtained by a Soviet research team on ordinary water are discussed. The method was used for determining the diffusion parameters of H_2O, Be, BeO, and graphite. (TTT)

9956 NEUTRON AGE MEASUREMENT IN GRAPHITE IMPREGNATED BY DIPHENYL. R. Bonalumi, C. Bruschi, and G. B. Zorzoli (Centro Informazioni Studi Esperienze, Milan). Energia nucleare (Milan), 7: 862-4(Dec. 1960). (In English)

The age of fission neutrons in graphite impregnated by diphenyl is measured by means of activation of indium detectors, using a natural uranium disk as a neutron source. The experimental technique is described and the experimental results are discussed. (auth)

9957 CALCULATION OF THE EFFECTIVE THERMAL CROSS-SECTION AND ITS TEMPERATURE COEFFICIENT, (I). Akinao Shimizu (Nippon Atomic Ind. Group Co., Ltd.). J. At. Energy Soc. Japan, 2: 611-17(1960). (In English)

An approximate expression for the effective thermal cross section of an element in the infinite homogeneous medium with 1/v absorption was derived from the monoatomic heavy gas model with the aid of the variational principle. Comparison with the exact numerical value shows that the error due to the derived approximate expression is only a few per cent in the range $0 \leq \Sigma_a\,(kT)/\xi\Sigma_s \leq 1.0$. An approximate expression for the epithermal reaction which is consistent with the derived one for the thermal reaction is also presented. (auth)

9958 ANALYSIS OF THE RESONANCES CAUSED BY "s" NEUTRONS IN TRANSMISSION EXPERIMENTS BY TIME-OF-FLIGHT. C. Corge, J. Julien, and F. Netter (Centre d'Etudes Nucléaires, Saclay, France). J. phys. radium, 21: 759-60(Oct. 1960). (In French)

For the analysis of resonances of s-wave neutrons, it is necessary to determine the parameters Γ (the total resonance length) and σ_0 (the maximum total cross section at right angles to the energy E_R). These parameters can be determined by comparison of experimental and theoretical curves. Several methods developed for this purpose are briefly cited. Bollinger's (ANL-5754) partial area method is extended by the calculation of the partial area A/Δ. The results are presented in the form of a curve lattice, of which an example is given. (J.S.R.)

9959 A ONE-GROUP MODEL FOR THERMAL ACTIVATION CALCULATIONS. R. J. Breen (Westinghouse Electric Corp., Pittsburgh). Nuclear Sci. and Eng., 9: 91-3(Jan. 1961).

In performing diffusion theory calculations, if the Wigner-Wilkins spectrum as calculated with the SOFOCATE code is used, the one-group diffusion equation is written as $-D_{SOF}\nabla^2_\phi + \Sigma_{SOF\phi} = S$, where S is a thermal source term. Calculations with the SLOP-1 multigroup thermal code with upscattering showed that, while the cross section as a function of position approaches the SOFOCATE value asymptotically, the diffusion coefficient is much closer to the Maxwellian average. Using observations from the SLOP-1 problems to modify the SOFOCATE equation for thermal group representation resulted in a diffusion equation in which the coefficients of the leakage term are averaged over a Maxwellian spectrum and the coefficients for the absorption term are averaged over a SOFOCATE spectrum. (M.C.G.)

9960 THERMAL NEUTRON FLUX IN A CELL WITH TEMPERATURE DISCONTINUITIES. D. S. Selengut (General Electric Co., Richland, Wash.). Nuclear Sci. and Eng., 9: 94-6(Jan. 1961).

In calculations of thermal neutron flux, the interpretation of lattice measurements, in which the part of the lattice being studied is held at elevated temperature, is complicated by uncertainties as to the width of the transition region caused by the temperature discontinuity. As an alternative to a straightforward multigroup approach to the solution of the problem, a method was developed which employs the formalism of few-group theory while retaining the qualitative features of neutron distribution in space and energy. The basic procedure is to approximate the actual neutron distribution by a superposition of overlapping thermal groups, one in equilibrium with each region of uniform temperature in the system. Neutrons in the nonequilibrium groups will then make transitions into the local equilibrium group at a rate that can be easily calculated. (M.C.G.)

9961 MAGNETIC MIRRORS, CHANNELS AND BOTTLES FOR COLD NEUTRONS. V. V. Vladimirskiĭ. Zhur. Eksptl'. i Teoret Fiz., 39: 1062-70(Oct. 1960). (In Russian)

As is well known, neutrons with spins oriented along the magnetic field are repulsed from high field regions. This permits one to employ magnetic mirrors and channels to obtain focused beams of polarized neutrons. The cold neutrons can be confined by restricting the vacuum cavity by magnetic mirrors. The adiabaticity conditions required for conserving the orientation of the spin relative to the field are considered. Possible magnetic field configurations, estimations of the polarized beam intensities, and neutron densities in the magnetic bottle are presented. (auth)

Nuclear Properties and Reactions

9962 (ANL-6220) TABLE OF ENERGY LEVELS OF ASYMMETRIC EVEN NUCLEI WITH BETA-VIBRATION-ROTATION INTERACTION. Paul P. Day, Ernest D. Klema, and Carlos A. Mallmann (Argonne National Lab., Ill.). November 1960. 24p. Contract W-31-109-eng-38.

The energy levels predicted by Davydov and Chaban's model were computed to compare theoretical predictions with experimental results. The computations were carried out for μ between 1.0, 0.90, 0.40, 0.35, and 0.1 and for γ between 8, 9, 10, 12, 15, 20, 25, and 30°. (W.L.H.)

9963 (ANL-6270) STUDY OF THE NUCLEAR ENERGY LEVELS ASSOCIATED WITH THE DECAY OF $_{66}Dy^{166}$, $_{69}Tm^{172}$, AND $_{68}Er^{172}$. R. G. Helmer and S. B. Burson (Argonne National Lab., Ill.). Jan. 1961. 142p. Contract W-31-109-eng-38.

An investigation was made of the energy levels of odd-odd nuclei, specifically those populated by the decay of Dy^{166} and Er^{172}. The decay of $_{69}Tm^{172}$, the daughter of Er^{172}, was also studied. The radionuclides were produced by the successive capture of two neutrons in the stable isotopes Dy^{164} and Er^{170}. A survey of the pertinent features of the theory of β decay and γ-ray transitions is presented. The single-particle and the unified models are discussed. Measurements were made with internal-conversion-electron spectrographs, a β spectrometer, and a multichannel scintillation coincidence spectrometer. Energy levels in $_{67}Ho^{166}_{99}$ were established at 0, 54.2, 82.5, 370, and 428 kev. The first three levels have spins 0, 2, and 1 and are interpreted as members of a rotational band with K = 0. From the decay of Tm^{172} a level scheme was constructed for the even-even nucleus $_{70}Yb^{172}_{102}$. The energies and the corresponding spin and parity assignments are 0 (0^+), 0.079 (2^+), 0.260 (4^+), 1.17 (3), 1.46 (2), 1.54 (3), 1.60 (1), 1.64 (?), and 1.73 Mev (3). It was concluded that the spin of the thulium ground state is I = K = 2 with negative parity. Interpretations in terms of the collective model are discussed. From the decay of Er^{172}, the energy levels and the corresponding spin and parity assignments in $_{69}Tm^{172}_{103}$ are 0 (2^-), 408, 450 or 160, 475 ± 15, 530 (0^+ or 1^+), and 610 kev (0^+ or 1^+). (auth)

9964 (JINR-D-502) STUDIES OF THE SECONDARY REACTION OF Li-CAPTURE IN LEAD. Yun-yui Van, V. V. Kuznetsov, M. Ya. Kuznetsova, V. N. Mekhedov, and V. A. Khalkin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab of Nuclear Problems). 1960. 16p.

Production of astatine isotopes (At^{211}, At^{210}, and At^{207}) in lead bombarded with 80 to 660-Mev protons, 75 to 370-Mev deuterons, and 210 to 810-Mev α particles was studied by the radiochemical method. The yield of At^{211} bombarded with α particles amounts to 0.3 microbarn and practically does not depend on the energy of α-particles. When bombarded with protons and deuterons the yield rose with increasing energy and especially when bombarded with protons of energy higher than 400 Mev and reached 0.2 microbarn at 660 Mev. The yield of At^{211} with respect to the thickness of a lead target was constant within 0.8 to 1.6 mm and decreased for targets less than 0.3 mm. The formation cross section and the energy spectrum of captured Li fragments were estimated by the yields of astatine isotopes from lead. The formation cross section of lithium fragments was 3 to 6 millibarn at 660 Mev. (auth)

9965 (NP-9690) ELASTIC SCATTERING OF 13 MeV DEUTERONS ON Al. N. Cindro, M. Cerineo, and A. Strzałkowski (Polish Academy of Sciences. Inst. of Nuclear Research. Krakow). June 1960. 9p. (162/OFJ).

The angular distribution of 13-Mev deuterons scattered elastically on aluminum was measured by means of the thin scintillation crystal technique. Although not so prominent as at 15 Mev, the increase of the differential cross section at backward angles was also observed at the deuteron energy of 13 Mev. The reason for back-angles maxima in elastic scatterings is so far unclear. (auth)

9966 (NYO-2959) THE POSITRON SPECTRA OF V^{46}, Mn^{50}, Co^{54}, AND Cu^{58} (thesis). John H. Miller, III (Princeton Univ., N. J. Palmer Physical Lab.). Nov. 1960. 108p. Contract AT(30-1)-937.

The four nuclides were produced by (p,n) reactions using 17-Mev protons from the Princeton FM-cyclotron. A lens type β spectrometer was placed with its source region directly in the external beam of the cyclotron, thus making the beam target serve also as the source for the spectrometer. Kurie plot analysis of the resulting data leads to end points and ft values. (W.D.M.)

9967 (ORNL-2963) KINEMATICS OF NUCLEAR REACTIONS CALCULATED WITH THE IBM-704 COMPUTER. B. D. Williams (Oak Ridge National Lab., Tenn.). Dec. 20, 1960. 9p. Contract W-7405-eng-26.

A program is described to be used with the IBM-704 computer to calculate certain kinematic quantities for any relativistic reaction of the form itt = otr. The target particle t is assumed to be at rest. (J.R.D.)

9968 (TID-6991) DECAY OF Na^{26}. E. L. Robinson, B. T. Lucas, and O. E. Johnson (Purdue Univ., Lafayette, Ind. Physics Dept.). 17p. Contract AT(11-1)-123.

The bombardment of high purity natural magnesium targets with fast neutrons from the $Li^7(d,n)Be^8$ reaction ($E_n \lesssim 24$ Mev) yielded, in addition to activities associated with well known isotopes, an activity having an experimental half life of 1.03 ± 0.06 sec. Scintillation spectrometer measurements showed a (1.82 ± 0.03)-Mev gamma and a (6.7 ± 0.3)-Mev beta group decaying with the 1.03-sec half life. The 6.7-Mev beta group was found to be in coincidence with the 1.82-Mev gamma ray. The assignment of the (1.03 ± 0.06)-sec half life to Na^{26} produced in the reaction $Mg^{26}(n,p)Na^{26}$ and the proposed decay scheme are supported by internally consistent arguments based on the known characteristics of the reaction products and their decay modes; the half life studies using both beta and gamma radiation: the features of experimental beta and gamma spectra, and nuclear systematics. The decay of the ground state of Na^{26} takes place in part by a (6.7 ± 0.3)-Mev beta transition to the (2+)-first excited state of Mg^{26}. The intensities of the beta transitions to the (2+)-second excited state and (0+)-ground state are less than 0.1 of the intensity of the (6.7 ± 0.3)-Mev transition. The possible ground state spin and parity assignment for Na^{26} is either 1+, 2+, or 3+. A weak theoretical argument against spin 1 is presented. The present experimental measurements alone will not reduct the ambiguity in the spin assignment. A Na^{26}–Mg^{26} mass difference of 8.5 ± 0.3 Mev is derived from the known level structure of Mg^{26} and the beta transition energy measured. (auth)

9969 (TID-6998) STUDIES OF ALPHA-PARTICLE INDUCED NUCLEAR REACTIONS IN MEDIUM WEIGHT NUCLEI. Technical Progress Report for period February 15, 1960–November 14, 1960. Brian D. Pate (Washington Univ., St. Louis). Nov. 14, 1960. 7p. Contract AT (11-1)-870.

Work on equipment construction and technique development is outlined, and experimental work is described. Work preliminary to measurement of excitation functions for (α,p) and (α,n) reactions in Mo^{92}, Mo^{100}, and Sn^{112} was begun. Decay scheme studies on Tc^{103} and Te^{115}–Sb^{115} are discussed. Short-lived silver fission products were also studied. (T.R.H.)

9970 (TID-11547) RESEARCHES ON THE REACTIONS OF THE LIGHT NUCLEI AND THE PENETRATION OF CHARGED PARTICLES IN MATTER. Progress Report, January 1, 1960–December 31, 1960. Samuel K. Allison (Chicago. Univ. Enrico Fermi Inst. for Nuclear Studies). 27p. Contract AT(11-1)-238.

Studies were continued on the transmutations of light nuclei having kinetic energies up to 2 Mev, and on the phenomena attending the passage of heavy ions through matter, emphasizing the charge changing collisions and stopping powers. An outline is given of the projects completed or under way during the reporting period. The technical developments completed include: a multiple filament ion source; a low noise vacuum tube amplifier for signals from solid-state detectors; the adaptation of excess Van de Graaff magnets; the Van de Graaff overhaul; and the kevatron ripple production. (B.O.G.)

9971 (UCOL-P-503) STUDIES OF GAMMA RAYS FROM NEUTRON INELASTIC SCATTERING. David A. Lind and Robert B. Day (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract AT(11-1)-535.

Measurements of the γ rays excited by neutron inelastic scattering in B^{11}, Na, Si, K, Sc, Zr, In, I, Ta, Au, Tl, and Pb^{206} were carried out by use of the conventional ring scatterer geometry within a neutron energy range from 0.2 to 3.5 Mev. The studies were used to obtain information on level structure, to determine cross sections for γ excitation, and to make a test of the predictions of inelastic scattering cross sections computed by a combination of the statistical and optical models. New levels and information on the decay schemes were found in zirconium, iodine, gold, and Pb^{206}. Excitation functions in terms of absolute cross sections are presented for the prominent γ rays in the spectra of all the elements studied except scandium and thallium. Studies of the γ rays from Pb^{206} gave experimental verification of the level scheme for the low spin states calculated by True and Ford. Statistical model calculations are presented which give reasonably good agreement with the experiments on Pb^{206}, provided the penetrabilities are calculated using parameters obtained from an analysis of elastic scattering data specifically for Pb^{206}. The analysis shows that the imaginary part of the optical potential is abnormally low for Pb^{206}, compared to that for neighboring nuclei at comparable energies. The agreement in magnitude and shape between the experimental and calculated excitation functions can be improved if the imaginary part of the potential is permitted to increase with neutron channel energy. (auth)

9972 (UCRL-9346) ELECTRONIC AND NUCLEAR PROPERTIES OF SOME RADIOACTIVE RARE-EARTH ELEMENTS (thesis). Amado Y. Cabezas (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 9, 1960. 162p. Contract W-7405-eng-48.

Ground-state nuclear spins of 13 radioactive rare earths (lanthanides) were measured by the atomic-beam magnetic-resonance method. Ground levels and corresponding g values were determined, and ground-state electronic configurations were inferred for Pm, Dy, Ho, and Er. In addition, electronic properties were verified for Pr, Nd, Sm, Gd, Tb, and Tl. The following isotopes were used in these investigations for which the half lives, nuclear ground-state spins, and J and g_J values are stated: Pr^{142}, Nd^{147}, Pm^{147}, Sm^{153}, Gd^{159}, Tb^{160}, Dy^{165}, Dy^{166}, Ho^{166}, Er^{169}, Er^{171}, Tm^{170}, and Tm^{171}. The magnetic dipole and electric quadrupole moments of the two odd-odd nuclei Pr^{142} and Tm^{170} are calculated from measurements of the hyperfine-structure separations. (T.R.H.)

9973 (UCRL-Trans-639) THE HYPERFINE STRUCTURE IN THE SPECTRUM OF LUTETIUM. Andreas Steudel. Translated from Z. Physik 152, 611-23(1958). 15p.

Measured ratios of the A and B factors of Lu^{175} and Lu^{176} are reported. The quantum number of the nuclear angular moment of Lu^{176} was determined from the component distances. The magnetic nuclear dipole moment and the electric nuclear quadrupole moment for Lu^{175} are evaluated. The nuclear moments for Lu^{176} are also calculated. (W.L.H.)

9974 ON THE HALF-LIFE OF P^{33}. Ingrid Fogelström-Fineman and Torbjörn Westermark (Royal Inst. of Tech., Stockholm). Acta Chem. Scand., 14: 2046-8(1960). (In English)

Because of discrepancies in values reported by other workers, the half life of P^{33} was measured. A 200-g sample of sulfur was irradiated in the outermost part of Jener for one month and then aged for two months. Another sample, 1 kg, was irradiated between the reflector and the concrete wall for one month and then aged for 6 months. The phosphorus activity was removed by precipitation with phosphate carrier then with lanthanum hydroxide carrier. Beta activity measurements were performed over a period of 6 months using an end-window G-M tube (1.4 mg/cm^2). The final result was 25.2 ± 0.5 days. (T.R.H.)

9975 CIRCULARLY POLARIZED BETA-GAMMA CORRELATION MEASUREMENTS ON Re^{186}. J. P. Deutsch and P. Lipnik (Univ., Louvain, Belgium). Ann. soc. sci. Bruxelles. Ser. I., 74: 195-9(Dec. 7, 1960). (In French)

Preliminary results of β-γ directional correlation polarization measurements at $\theta = 180°$ on nonunique first-forbidden β transitions of Re^{186} are given. Polarization found ($A' = 1.04 \pm 0.29$) furnishes an additional proof that this transition can not be described in the framework of the ξ-approximation. Measurements are now extended to other values of θ. (auth)

9976 PHOTOPROTONS FROM FLUORINE. B. Forkman and I. Wahlström. Arkiv Fysik, 18: 339-51(1960). (In English)

The results of a study of the (γ,p) reaction in F^{19} are presented. Thin foils of teflon were irradiated with bremsstrahlung of 15.5 and 19 Mev maximum energy. The photoprotons were recorded by nuclear emulsions. Each irradiation gives a proton spectrum containing well-resolved peaks. The peaks in the low-energy spectrum correspond to transitions from excited states in F^{19} to the ground state in O^{18}. The information about these transitions was then then used to analyze the high-energy spectrum. The proton spectrum at the high-energy irradiation is interpreted as transitions from resonances in F^{19} to the ground state and excited states in O^{18}. The observed fine structure in the (γ,p) absorption was compared with measurements of (γ,n); the agreement was found to be quite satisfactory. The

angular distribution of the protons was measured and gave further information about the photon-absorption process. (auth)

9977 ON THE RANGE OF SPALLATION PRODUCTS. G. Rudstam. Arkiv. Fysik, 18: 357-63(1960). (In English)

The ranges to be expected for spallation products were studied by extending the Monte Carlo analysis of nucleon-nucleon cascades inside nuclei to the case of reactions between 170-Mev protons and arsenic. The kinetic energy and direction of the residual nucleus with respect to the incoming protons and its angular distribution were evaluated, and their average energy was found to be 0.73 Mev. For the spallation products, a range of 0.53 μ corresponding to the value of 0.73 Mev for the average kinetic energy of the residual nucleus was found, and the relations between the mass of the products, range, and excitation energy were calculated and found to be in qualitative agreement with experimental data. (D.L.C.)

9978 PROTON ANGULAR DISTRIBUTIONS FROM d + D REACTION FOR DEUTERON ENERGIES 0.5–0.9 MEV. Zdzisław Sawa. Arkiv Fysik, 18: 365-8(1960). (In English)

The angular distributions of protons from the D(d,p)T reaction were measured at deuteron beam energies of 0.5 to 0.9 Mev and at laboratory angles of 15 to 135°. The results were put in the form of $\sigma(\theta^\circ)/\sigma(90^\circ) = k(1 + A\cos^2\theta + B\cos^4\theta)$ and the coefficients A and B compared with those of Wenzel et al., for <0.5 Mev and Blair et al., for >1.0 Mev on an energy-dependent graph. No serious discrepancy appeared between the results of Wenzel and those of Blair. It is also concluded that the above equation fits the data better than stripping theory. (D.L.C.)

9979 NOTE ON COLLECTIVE EXCITATION OF ODD NUCLEI OF SUPPOSED "SPHERICAL" CORE. Olov Bergman. Arkiv Fysik, 18: 379-84(1960). (In English)

A search for levels of possible collective character was made in odd nuclei, particularly cadmium, tellurium, and xenon isotopes, whose levels are discussed in detail. Some medium mass nuclei and platinum isotopes are also considered. Inconclusive evidence was found for collective excitations in a few odd neutron nuclei, while no support was found for a vibrational level in nuclei of odd atomic number. It is emphasized that studies of collective effects are needed to help explain excitation processes in nuclei. (D.L.C.)

9980 THE YIELDS OF FISSION FRAGMENTS PRODUCED FROM U^{233} AND Pu^{239} BY FAST NEUTRONS. E. K. Bonyushkin, Yu. S. Zamyatnin, V. V. Spektor, V. V. Rachev, V. R. Negina, and V. N. Zamyatnina. Atomnaya Energ. 10: 13-18(Jan. 1961). (In Russian)

The absolute yields of fragments from U^{233} and Pu^{239} fission by 14.5-Mev neutrons and fission neutrons were determined. Certain regularities were observed in the fragment distribution curve in relation to fragment mass. The relation between the difference in the mean mass of heavy and light fragment Δm and the mass number of the fissioned nucleus is discussed. (tr-auth)

9981 THE MEAN NUMBERS $\bar{\nu}$ AND η OF NEUTRONS PRODUCED IN FISSION FROM U^{233} AND Pu^{239} BY NEUTRONS OF ENERGY 14 MeV. N. N. Flerov and V. M. Talyzin. Atomnaya Energ. 10: 68-9(Jan. 1961). (In Russian)

A fast neutron detector with a graphite prism was used for measuring the absolute intensities of mean neutron number ν and η formed in 14-Mev neutron fission and inelastic interactions with U^{235} and U^{238} and for measuring the cross sections of (n,2n) reactions on beryllium, lead, and bismuth. The neutron flux was determined by the number of α particles from $T(d,n)He^4$ reactions. The magnitudes $1 + \gamma$ (the coefficient considering the increased number of neutrons from fission by secondary neutron) are tabulated. For U^{233} and Pu^{239}, $\sigma_{inel} = (2.85 \pm 0.10)$ barn. The $\bar{\nu}$ magnitudes for U^{233}, Pu^{239}, U^{235}, and U^{238} at 14 Mev are almost identical and close to (4.4 ± 0.2). The data for $\bar{\nu}$ are in good agreement with published data. (R.V.J.)

9982 NOTE ON THE THERMAL NEUTRON CAPTURE CROSS SECTION OF Cs^{133}. A. P. Baerg and R. M. Bartholomew (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 38: 2528-31(Dec. 1960). (AECL-1110)

An investigation was made of the cross sections for the $Cs^{133}(n,\gamma)Cs^{134m}$ reaction, and the reactions leading to the ground state. The irradiated cesium chloride samples were counted with a $4\text{-}\pi\ \beta\text{-}\gamma$ coincidence counter. The method used to calculate the cross sections is outlined. The cross section for 2200 m/sec neutrons for Cs^{134m} production is $\sigma_0 = 2.82 \pm 0.07$ barns. The effective cross section leading to the ground state Cs^{134} is $\delta = 41.6 \pm 0.9$ barns. (B.O.G.)

9983 NUCLEAR ORIENTATION IN ANTIFERROMAGNETIC SINGLE CRYSTALS. J. M. Daniels, J. C. Giles, and M. A. R. LeBlanc (Univ. of British Columbia, Vancouver). Can. J. Phys., 39: 53-64(Jan. 1961).

Mn^{54} and Co^{60} were successfully oriented in five antiferromagnetic single crystals ($MnCl_2 \cdot 4H_2O$, $MnBr_2 \cdot 4H_2O$, $CoCl_2 \cdot 6H_2O$, $Co(NH_4)_2(SO_4)_2 \cdot 6H_2O$, and $MnSiF_6 \cdot 6H_2O$) and the orientation was detected by the anisotropy of the emitted γ rays. Only in the case of Co^{60} in $MnBr_2 \cdot 4H_2O$ was no γ-ray anisotropy seen. It is concluded that antiferromagnetism can be used as a means of producing nuclear orientation. Attempts to orient Br^{82} and I^{131} in the manganese halides by superexchange were unsuccessful. (auth)

9984 THE NUCLEAR SPIN OF INDIUM-115m. H. J. King, J. A. Cameron, H. K. Eastwood, and R. G. Summers-Gill (McMaster Univ., Hamilton, Ont.). Can. J. Phys. 39: 230-1(Jan. 1961).

The nuclear spin of the 4.5-hr metastable state of In^{115} was measured using the flop-in method of atomic beam magnetic resonance. A single low-frequency resonance was found corresponding to $J = \frac{1}{2}$, $I = \frac{1}{2}$; this is in agreement with the assignment M4 for the γ ray transition between the metastable state and the $I = \frac{9}{2}$ ground state. The samples were found to decay with a half life of 4.4 ± 0.4 hr. The procedures used in the chemical separation of indium from irradiated cadmium are given. (D.L.C.)

9985 ON THE POSSIBILITY OF OBSERVING COOPERATIVE PHENOMENA IN NUCLEAR MAGNETISM. Anatole Abragam (Centre d'Etudes Nucleaires, Saclay, France). Compt. rend., 251: 225-7(July 11, 1960). (In French). (CEA-1647)

The conditions for the appearance of co-operative phenomena in nuclear magnetism are discussed, and methods for their observation are presented. (auth)

9986 THE INTERACTION ENERGY OF THE LAST NEUTRON AND THE LAST PROTON OF ODD-ODD NUCLEI. Christian Ythier and Ruurd Van Lieshout. Compt. rend., 251: 2332-4(Nov. 21, 1960). (In French)

The variation of the interaction energy of the final neutron and the final proton of odd-odd nuclei as a function of the number of neutrons appears to have fine structure in probable relation with the constitution of the even-even core. This fine structure is compared with an analogous

structure observed in the variation, as a function of the number of neutrons, of the excitation energy of the first 2^+ level of even-even nuclei. (tr-auth)

9987 γ RADIATIONS PRODUCED BY THE BOMBARDMENT OF BERYLLIUM-9 BY DEUTERONS FROM 2 TO 5.6 MEV. Martin Suffert, Denise Magnac-Valette, and Jean Yoccoz. Compt. rend., 251: 2335-37(Nov. 21, 1960). (In French)

The γ yield from the reaction $Be^9(d,\gamma)$ was studied for deuteron energies between 2 and 5.6 Mev. Two γ rays, one with energy equal to the excitation energy and the other 2 Mev below that of the first, were detected. The preliminary results on the variation of the cross section were given. (tr-auth)

9988 NEUTRON-DEFICIENT ISOTOPES OF TERBIUM WITH HALF-LIFE OF 18 HOURS. J. Frâna, I. Rezanka, M. Vobecký (Czechoslovak Academy of Science, Prague), and V. Hušák. Czechoslov. J. Phys., 10: 692-3 (Sept. 1960). (In English)

The terbium isotopes having mass numbers <159 and half lives ~18 hrs were investigated. The isotopes were obtained from a proton-irradiated tantalum target. Most of the lines of the spectrum corresponded to Tb^{153}, Tb^{155}, and Tb^{156}. The continuous spectrum was separated into the components 2830, 1550, and 800 kev, with relative intensities of 67 : 20 : 13. An indication was found of a component with E_{max} = 1100 kev. Of the known conversion lines of Tb^{154}, only the strongest was found, at 123 kev; weaker lines were not observed and the other conversion lines were ascribed to a $Tb^{151+152}$ mixture. The energies of the corresponding transitions and the relative intensities of the conversion lines are tabulated. The accuracy in energy determinations is 0.3%, with weak lines >700 kev at 0.6%; the error of intensity determinations is 10 to 20%. (B.O.G.)

9989 MEASUREMENT OF NEUTRON SPECTRA FROM (d,n) REACTIONS ON LIGHT NUCLEI. J. Juna, P. Horváth, and K. Konečný (Institute of Nuclear Research, Czechoslovakian Academy of Science, Prague). Czechoslov. J. Phys., B10: 715-21(1960). (In English)

A description is given of a fast neutron spectrometer, based on the principle of measuring the time-of-flight of the neutrons. Neutron bursts were formed in a target by deflection of the ion beam of an accelerator by a radio-frequency voltage on the deflector. The time-of-flight of neutrons was measured by a slow-fast coincidence system with fast coincidence on the measuring line. The spectrometer was used to measure the neutron spectra of the reactions $D(d,n)He^3$, $T(d,n)He^4$, $Li^7(d,n)Be^8$, $Li^7(d,n)2\alpha$, $Be^9(d,n)B^{10}$. Neutrons with energy 4.06 Mev from the reaction $Li^7(d,n)Be^9$ were not previously reported in the literature. They correspond to the 11.7-Mev level in the nucleus Be^8, known from other nuclear reactions. (auth)

9990 DECAY OF $Nd^{140} \rightarrow Pr^{140} \rightarrow Ce^{140}$. V. Brabec, B. Kracík, and M. Vobecký (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Czechoslov. J. Phys., 10: 855-9(1960). (In English)

An intermediate image magnetic spectrometer was used to study the continuous β^+ spectrum of Pr^{140} and the Auger electrons of the decay chain $Nd^{140} \rightarrow Pr^{140} \rightarrow Ce^{140}$. The maximum energy of the continuous β^+ spectrum was 2318 ± 10 kev. The ratio of the intensities of the different Auger groups K − LL : K − LX : K − MX = 1 : (0.58 ± 0.05) : (0.09 ± 0.02). The ratio of the number of Auger electrons of the K-series to the electrons of the continuous spectrum e_K/β^+ was 0.292. (auth)

9991 NUCLEAR PHOTOPROCESSES. H. Wäffler (Max-Planck-Institut für Chemie, Mainz). Helv. Phys. Acta, Suppl., 5: 83-100(1960). (In German)

A review is presented in two parts: light and medium-heavy nuclei (work at Zurich 1941 to 1950); and photofission of deuterons at quantum energies between 5 and 25 Mev. (T.R.H.)

9992 THE DYNAMIC POLARIZATION OF NUCLEI. J. Combrisson (Centre d'Études Nucléaires, Saclay, France). Inds. atomiques, 4: No. 9-10, 53-7(1960). (In French)

After a brief résumé of the essential properties of nuclear magnetism and magnetic resonance, the conditions under which a polarization of the nucleus can be obtained are studied. For the particular case of nuclei contained in a target to be placed in front of an accelerator beam, the experimental requirements are such that the usual techniques such as adiabatic demagnetization can not be used. A method using dynamic polarization is described, and the principle of the experimental apparatus and the first results obtained are indicated. (tr-auth)

9993 IDENTIFICATION OF GAMMA EMITTERS FORMED BY NEUTRON ACTIVATION INCLUDING TABLES OF RADIONUCLIDES FORMED BY NEUTRON CAPTURE. T. Westermark and B. Sjöstrand (Royal Inst. of Tech., Stockholm). Intern. J. Appl. Radiation and Isotopes, 9: 63-77(Dec. 1960). (In English)

Gamma-emitting nuclides formed by neutron capture (and some other neutron reactions) can be identified by measuring the half life and γ energy preferably against a standard which might be the nuclide suspected. The uncertainty of these two properties is used to form an uncertainty rectangle around a point on a map with the half life on one axis and γ energy on the other. Maps are given of neutron-formed γ-emitting nuclides (except fission products) as listed in the Strominger-Hollander-Seaborg tables to facilitate such identification work which may be met in any radiochemical procedure, activation analysis, reactor product contamination, and other work. (auth)

9994 ENERGY SPECTRA OF CORRELATED FRAGMENT PAIRS FROM THE SPONTANEOUS FISSION OF Cf^{252}. W. T. Joyner, H. W. Schmitt, J. H. Neiler, and R. J. Silva (Oak Ridge National Lab., Tenn.). IRE Trans. Nuclear Sci., NS-8: No. 1, 54-8(Jan. 1961).

Silicon surface barrier counters were used in conjunction with specially-designed low noise amplifiers to measure the energies of correlated fragment pairs from the spontaneous fission of Cf^{252}. The silicon counters, ¼ by ¼ in. in size and prepared from 3600 ohm-cm material, exhibited rise times for fission pulses of a few nanoseconds; the pulse height resolution obtained for natural α particles was 0.5%. The energy response of the present counters to fission fragments appeared to be slightly nonlinear. Pulses from coincident fragment pairs were analyzed and recorded in a 100 by 100 channel coordinate recorder. Approximately 3×10^5 events were recorded on punched paper tape and sorted on the ORACLE. Preliminary results including the deduced relative mass yields are shown, as well as pulse-height and energy spectra. (auth)

9995 Sn^{119} NUCLEAR MAGNETIC RESONANCE SPECTRA. John J. Burke and Paul C. Lauterbur (Mellon Inst., Pittsburgh). J. Am. Chem. Soc., 83: 326-31(Jan. 20, 1961).

The Sn^{119} spectra of a number of organic and inorganic tin compounds were obtained. Chemical shifts of over 1800 ppm were found and indirect spin-spin couplings with pro-

tons in alkyl groups were observed to be of the order of 50 to 100 cps. The spectra of mixtures of $SnCl_4$, $SnBr_4$, and SnI_4 were examined, and all of the twelve possible mixed tin (IV) halides, including the previously unreported $SnBrI_3$, $SnBr_2I_2$, and $SnBr_3I$, and $SnClBrI_2$, $SnClBr_2I$, and $SnCl_2$-BrI, were found to present in the concentrations expected for random halogen exchange. The average lifetimes of the halide molecules in the mixtures were found to be between 10^{-2} and 10 seconds. Solvent effects upon the Sn^{119} chemical shifts of various tin compounds were observed and the Sn^{119} chemical shift of $SnCl_2 \cdot 2H_2O$ in aqueous solution was found to be dependent upon the concentration of added hydrochloric acid. (auth)

9996 SCATTERING OF METASTABLE HELIUM ATOMS IN HELIUM, NEON, AND ARGON. G. M. Smith and E. E. Muschlitz, Jr. (Univ. of Florida, Gainesville). J. Chem. Phys., 33: 1819-25 (Dec. 1960).

Total collision cross sections for the scattering of metastable 2^3S and 2^1S helium atoms in helium, neon, and argon were measured using a thermal-energy atomic beam in which a fraction of the helium atoms are excited by electron bombardment. The excited particles are detected by measuring the secondary electron emission from metal surfaces. The cross sections for the scattering of the triplet atoms are larger than for the singlet in each case. For neon the difference is considerably greater than the estimated experimental error, indicating a large difference in the interaction potentials. (auth)

9997 A CLOSED GENERAL SOLUTION OF THE PROBABILITY DISTRIBUTION FUNCTION FOR THREE-DIMENSIONAL RANDOM WALK PROCESSES. Chi-hua Hsiung, Hsien-chih Hsiung, and Adon A. Gordus (Univ. of Michigan, Ann Arbor). J. Chem. Phys., 34: 535-46(Feb. 1961).

A closed general solution of the probability distribution function for three-dimensional random walk processes is derived. For the particular case of equal-length displacements, the exact solution is compared with the Gaussian approximation for n = 3, 5, and 10 steps. The general solution is utilized in calculating the probability distribution of γ-ray energies resulting in the Cl^{35} (n,γ) Cl^{36} process. For five unequal steps of fractional length: 0.582, 0.135, 0.131, 0.092, and 0.060 (which is somewhat characteristic of the fractional energies of γ rays resulting from neutron capture), the exact solution is compared with a Gaussian, a modified Gaussian, and a five equal-step approximation. There are presented the specific solutions for all possible unequal-length random displacements involving n = 2, 3, and 4 steps. (auth)

9998 PREPARATION OF UNIFORM RESISTIVITY n-TYPE SILICON BY NUCLEAR TRANSMUTATION. M. Tanenbaum and A. D. Mills (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Electrochem. Soc., 108: 171-6 (Feb. 1961).

By the capture of a thermal neutron, the natural isotope Si^{30} can be transmuted into the unstable isotope Si^{31}, which decays by beta emission with a 2.62-hr half life to the stable isotope P^{31}. By means of this reaction, donors can be produced in a silicon crystal. Because of the uniformity of flux which can be obtained in large nuclear reactors, this technique lends itself to the preparation of uniformly doped n-type silicon. After irradiation, the silicon crystal is heavily damaged by the emitted betas, by the recoil of the decaying Si^{31}, and by the high-energy neutrons that are unavoidably present in the reactor. However, this damage can be removed by annealing at temperatures near 600°C. The technique was used to produce n-type silicon with nominal resistivities between 0.1 and 20 ohm-cm. The resistivity of the resulting crystals was uniform over dimensions of 5 cm to within ± 5%. (auth)

9999 PROBABILITIES OF γ TRANSITION (M_2) IN SOME HEAVY NUCLEI. R. Foucher (Inst. du Radium, Orsay, France). J. phys. radium, 21: 751(Oct. 1960). (In French)

In the de-excitation of levels of heavy nuclei there appears to be competition between the dipole electric transition (E_1) and the quadrupole magnetic transition (M_2). It is possible to obtain information on the percentage of M_2 transitions mixed with E_1 transitions from the internal conversion coefficient αL_{III}. In the case of the 59.6-kev transition of Np^{237}, the 84.2-kev transition of Pa^{231}, and the 27.5-kev transition of Ac^{227}, an upper limit of the M_2 transition can thus be determined. As the total probability for the emission of γ radiation is known, a maximum value for the probability of magnetic quadrupole radiation can be deduced. In the case of the 236-kev transition of Ra^{223}, the percentage of M_2 transition was determined by an angular correlation measurement γ(236 kev)-γ(50 kev) with sources of various viscosities. It appears that the experimental transition probabilities (M_2) are for these nuclei much lower than that predicted by the independent particle model. (J.S.R.)

10000 NEW ISOTOPES WITH A SHORT PERIOD OBTAINED BY THE SPALLATION OF GOLD. G. Albouy, M. M. Gusakow, and N. Poffe (Laboratoire de Physique Nucléaire, Orsay, France). J. phys. radium, 21: 751-3 (Oct. 1960). (In French)

During a study of the spallation of gold, mercury isotopes of mass 185 to 190 and their descendents were obtained after double electromagnetic separation. The short-lived isotopes with mass 187, 186, and 185 were observed by a scintillator at the interior of the separator. The analyses of the γ spectra and the decomposition of the decay curves have permitted the evaluation of periods and the energy of the principal γ rays. The period and the energy of the principal γ rays of the isotopes 190, 189, 188, 187, 186, and 185 of mercury, gold, and platinum are tabulated. (J.S.R.)

10001 BASIS OF PARAMAGNETIC NUCLEAR RESONANCE. A. Lösche (Karl Marx Univ., Leipzig, Germany). Kerntechnik, 2: 345-8(Nov. 1960). (In German)

A brief introduction to the description of the nuclear moments is given. From the elementary quantum theory and from the classical representation of gyroscopic motion, the resonance effect is derived and the magnitudes of the observable potentials are estimated. The experimental technology of simple scanning methods is treated, and application possibilities are indicated. (tr-auth)

10002 OPTICAL HYPERFINE STRUCTURE OF NEON-21. Ebbe Rasmussen and V. Middelboe (Univ. of Copenhagen and Royal Veterinary and Agricultural Coll., Copenhagen). Kgl. Danske Videnskab. Selskab, Mat.-fys. Medd., 32: No. 14, 1-15(1960). (In English)

Using a highly enriched Ne^{21} sample, the hyperfine structure splitting in a number of terms of the arc spectrum was determined. The spectroscopic procedure used in this study is described. All the measured lines represent 1s-2p combinations. In the case of the spectral lines with wavelengths of 5852, 6074, and 6266A, the line splittings were directly equal to the splittings of terms $1s_2$, $1s_4$, and $2p_5$, respectively. The hyperfine structure separations of $2p_2$ were evaluated at 4 and 6 units. Values of total line splitting, measured line intervals, and term separations are given. (M.C.G.)

10003 HYPERFINE SPLITTING OF RUBIDIUM-87. L. Essen, E. G. Hope, and D. Sutcliffe (National Physical Lab., Teddington, Middx., Eng.). Nature, 189: 298(Jan. 28, 1961).

Rubidium has been used in the development of gas cell frequency standards, and from measurements of the variation of frequency with the pressure of the buffer gas used in the cell it has been deduced that the frequency corresponding to zero gas pressure is: 6,834,682,608 cps ± 7 cps where the second of time is that giving 9,192,631,770 cps for the cesium hyperfine structure splitting at zero field. It has been found, however, that when cesium is used in a gas cell the extrapolated frequency is 30 cps lower than the value given above obtained by an atomic beam experiment. There is therefore considerable interest in the atomic beam value for rubidium. For this purpose the oven of the long beam chamber at the National Physical Laboratory was filled with a mixture of Rb^{87} and Cs^{133}. A strong beam of atoms was obtained at an oven temperature of 120°C, and the application of the appropriate radio-frequency produced, alternatively, resonances of the rubidium or cesium atoms. The amplitude of the cesium resonance was 50% greater than that of rubidium, the higher vapor pressure of cesium presumably compensating for the fact that a greater proportion of the rubidium atoms take part in the resonance. In both cases the signal-to-noise ratio was adequate for the precise measurement of the frequencies corresponding to the resonance peaks. The rubidium resonance, which was 71 cps wide, was excited in cavities independently tuned and separated by a distance of 254 cm. It was slightly asymmetrical, but the asymmetry was measured and a correction applied. The value on the atomic time-scale corrected for the asymmetry and magnetic field is: 6,834,682,614.0 ± 1 cps. It is proposed to continue measurements of the two atomic transition frequencies. (auth)

10004 THE COLLECTIVE MODEL OR DEFORMED NUCLEI WITHOUT AXIAL SYMMETRY. P. Boskma (Natuurkundig Laboratorium, Groningen, Netherlands). Ned. Tijdschr. Natuurk., 26: 175-87(June 1960). (In Dutch)

The validity of the Bohr-Mottelson (BM) model and of the Davydov-Filippov (DF) model for deformed nuclei is compared. The DF model gives for deformed nuclei that are not not too far from closed shells a good explanation of the theoretical conditions and the transition probabilities. Especially for nuclei in the vicinity of the point where abrupt changes of the equilibrium deformation occur, the DF model usually gives much better results than the BM model. In this area, therefore, a very strong deflection of the axial symmetry seems to appear. For the case of strong coupling far from closed shells the explanation based on the DF model is sometimes better and sometimes worse than that based on the BM model. Possibly the models are more or less complementary. (J.S.R.)

10005 SPECTRAL INTENSITY DECOMPOSITION IN GAUSSIAN CURVES. L. G. Preuss and J. P. Escarfail (Ecole Polytechnique Fédérale, Zurich). Nuclear Instr. & Methods, 9: 212-20(Nov. 1960). (In French)

The increasing precision of measuring methods such as nuclear spectrography calls for a fast and sensitive method of decomposition into Gaussian curves, particularly if a suspected smaller maximum is smoothed out by a neighboring band. The resulting asymmetrical intensity curve is then often considered as the sum of two curves described by formula and having a common half-width h. A simple graphical method is proposed which allows one to check whether such a decomposition is significant to a given degree of accuracy. It also gives accurate values for the parameters D_1, D_2, v_1, v_2, and h with comparative ease. It follows that, even in the general case, an automatic recording of the logarithmic derivative on which this method is based will allow a more critical insight of any such intensity curve known to better than 1%, by making full use of the available precision. This in turn strongly suggests the use of a computer coupled to the spectrograph for that purpose. (auth)

10006 NUCLEAR REACTIONS FROM RECOIL PROTONS IN A REACTOR. S. S. Glickstein and R. G. Winter (Pennsylvania State Univ., University Park). Nuclear Instr. & Methods, 9: 226-8(Nov. 1960). (In English)

Samples of H_3BO_3, $(C_2H_4)_n$ and H_2O were exposed to the fast neutron flux next to the core of a 10^5-watt "swimming pool" reactor. The reactions $B^{11}(p,n)C^{11}$, $C^{12}(p,\gamma)N^{13}$, $C^{13}(p,n)N^{13}$, and $O^{18}(p,n)F^{18}$ were initiated by recoil protons and the positron activities of the products were observed. The yields, in atoms produced per gram of sample per second of irradiation, were 5000 for C^{11}, 800 for N^{13}, and 100 for F^{18}. The fast neutron spectrum was measured with threshold detectors, and the yields were computed. The agreement of the calculated and measured results is good. (auth)

10007 DISINTEGRATION OF ^{66}Ge. R. A. Ricci, R. K. Girgis, and R. Van Lieshout (Instituut voor Kernphysich Onderzoek, Amsterdam). Nuclear Phys., 21: 177-88 (Nov. 5, 1960). (In English)

The decay of Ge^{66} was investigated by scintillation techniques. The β- and γ-ray spectra were measured and the experimental results are given. Gamma-gamma coincidences were performed, and the results are reported. On the basis of these data, a decay scheme is proposed, and some features of the Ge^{66} disintegration are discussed. (auth)

10008 ELASTIC SCATTERING OF 24.4 Mev DEUTERONS BY PROTONS. W. T. H. Van Oers and K. W. Brockman, Jr. (Instituut voor Kernphysich Onderzoek, Amsterdam). Nuclear Phys., 21: 189-95(Nov. 5, 1960). (In English)

The differential cross section for the elastic scattering of 24.4 Mev deuterons by protons (equivalent to 12.2 Mev p–d scattering) was measured at angles between 15 and 170° in the center of mass system with an over-all accuracy of the order of 3%. The measurements stand in good agreement with recent measurements near 10 and 14 Mev and show the same apparent disagreement with the theory of Christian and Gammel in the Coulomb-nuclear interference region. (auth)

10009 EXPERIMENTAL EVIDENCE FOR CLUSTER STRUCTURES IN LIGHT AND MEDIUM WEIGHT NUCLEI. Raymond K. Sheline and Karl Wildermuth (Florida State Univ., Tallahassee). Nuclear Phys., 21: 196-219(Nov. 5, 1960). (In English)

The assumption in accordance with the cluster model is that nuclei may be considered to be composed of clusters (single nucleons, H^2, He^3, H^3, He^4, etc.). Comparison of cluster model predictions and experimental level schemes are made for the nuclei Li^7, Be^7, C^{12}, O^{16}, F^{19}, Ne^{20}, Ca^{40}, and Sc^{43}. It is shown that comparisons between the spectra of certain pairs of nuclei are particularly relevant from the viewpoint of the cluster model. Comparisons of the spectra of the following pairs of nuclei are made: N^{16}, O^{17}, F^{19}, Ne^{20}, K^{40}, Ca^{41}; and Sc^{43}, Ti^{44}. In addition, the cluster model predicts levels of parity different from the ground state. The relative position of these nuclei are compared in nuclei in which the smallest cluster is varied from a single nucleon to larger clusters. This model further

predicts that immediately after double closed-shell structures, nuclei with H^3 or He^3 clusters (e.g., F^{19}) will exhibit a strong decrease in this excitation energy. The negative parity states and first 0+ states in α-particle nuclei should decrease with increasing atomic number. These predicted systematics agree with the limited experimental data which are available but suggest the need for considerable additional data to further test the predictions. These results indicate substructures which are often more important than shell-model structures. (auth)

10010 REMARKS ON THE ENERGY DISTRIBUTION OF MESONS CREATED IN HIGH-ENERGY NUCLEAR COLLISIONS. E. M. Friedländer (Inst. of Atomic Physics, Bucharest). Nuclear Phys., 21: 220-4(Nov. 5, 1960). (In English)

It is shown that the assumption of a Heisenberg type spectrum of the secondaries from high-energy mesons jets is in contradiction with the observed distribution of c.m.s. angles and that of the transverse momenta. Starting from observational data on the latter quantities, a rough approximation for the c.m.s. energy spectrum is computed. (auth)

10011 AN IMPROVED APPROXIMATION FOR SCATTERING PROBLEMS. [PART] II. P. Swan (Univ. of Melbourne). Nuclear Phys., 21: 233-6(Nov. 5, 1960). (In English)

A previously developed method of calculating scattering phase shifts is improved for long-tailed potentials by using a better form factor $g_l(r)$, which takes into account distortion of the wave function by the potential tail. A numerical comparison for S^3 and S^1 neutron-proton scattering is made for wells of gaussian, exponential, and Yukawa shape. Comparison of results with the previous ones shows a reduction in error of more than half for nonsingular potentials for which satisfactory $g_l(r)$ can be constructed, such as the exponential potential. Singular potentials such as the Yukawa well give the least satisfactory results since satisfactory $g_l(r)$ cannot be constructed in the usual simple way, owing to neglect of logarithmic terms in the distorted wave function. (auth)

10012 DISPERSION FORMULAS IN THE THEORY OF NUCLEAR REACTIONS. V. I. Serdobolskii (Serdobolsky) (Lebedev Inst. of Physics, Moscow). Nuclear Phys., 21: 245-55(Nov. 5, 1960). (In English)

A theory of resonances in nuclear reactions is offered in which the concept of the R-matrix is not used. Under consideration is a certain parameter whose smallness makes it possible to select from the total number of formal levels obtained in the theory the resonance levels attributable to the formation of the long-lived compound nucleus. For the levels which do not overlap the nuclear-reaction thresholds, the compound nucleus resonances are singled out by the poles of a Green's function at complex energies. The dispersion formulas thus obtained are linear with respect to resonances and contain the complex reduced half widths. These formulas do not depend on auxiliary hypersurface radii and take into account the tails of wave functions responsible for multiparticle processes occurring close to the surface of the nucleus. (auth)

10013 THE INTERACTION RADIUS IN DIRECT REACTIONS. Leonard S. Rodberg (Los Alamos Scientific Lab., N. Mex. and Univ. of Maryland, College Park). Nuclear Phys., 21: 270-5(Nov. 5, 1960). (In English)

In the direct interaction theory of nuclear reactions, a parameter appears which describes the radius of the surface region in which the direct interaction takes place. Fits to experimental data using Born approximation theories lead to interaction radii that are considerably larger than nuclear radii determined by other means. It is suggested that this is a simple consequence of the distortion of the incident and outgoing waves, described in terms of an optical potential. This potential increases the relative momentum in the region of interaction, leading to smaller interaction radii for a given angular-momentum transfer. The energy independence of observed direct reaction angular distributions can also be understood in terms of the modified momentum inside the nuclear potential. (auth)

10014 ON CONSERVATION OF PROBABILITY IN THE LEE MODEL. Philippe Dennery and Norman M. Kroll (Columbia Univ., New York). Nuclear Phys., 21: 276-99 (Nov. 5, 1960). (In English)

Heisenberg's treatment of the Lee model in an indefinite metric with dipole or complex ghosts is extended to include more than one heavy particle and to include heavy particle motion. It is shown that with this extension new bound states of negative norm and real energy appear, which can, via a scattering process, lead to a failure of unitarity in the theory. (auth)

10015 EXTRA SOLUTIONS OF THE DISPERSION RELATIONS AND RESONANCE SCATTERING. A. O. Barut and K. H. Ruei (Syracuse Univ., N. Y.). Nuclear Phys., 21: 300-9(Nov. 5, 1960). (In English)

The connection between the extra solutions of the dispersion relations plus the unitarity condition and the existence of unstable intermediary states is discussed. It is shown for the potential scattering that both lead to a resonance behavior in the cross section. The dispersion relation and the unitarity condition describe, therefore, a quantal system whose spectrum is enlarged by the inclusion of unstable intermediate states. (auth)

10016 ENERGY LEVELS OF Be^9 AND B^9. R. R. Spencer, G. C. Phillips, and T. E. Young (Rice Univ., Houston, Tex.). Nuclear Phys., 21: 310-26(Nov. 5, 1960). (In English)

The low-lying energy levels of Be^9 and B^9 were investigated by means of a magnetic analysis of the $Be^9(p,p')Be^9$ and $B^{10}(He^3,\alpha)B^9$ reactions. Several distinctive features of the data result in a model being proposed to describe the low-lying energy level structure of these mirror nuclei. The model describes the mass nine nuclei as two-body cluster states of $Be^8(0^+)$ + nucleon and $Be^8(2^+)$ + nucleon and gives quantitative agreement with the experimental width of the states. A generalized density of states function is employed to describe the continuum spectra and allows a description of the cusp effects in the spectra of the two nuclei as aspects of two-body cluster spatial localization and many-body decay occurring as a sequence of two-body separations. (auth)

10017 THE SIGNIFICANCE OF THE GENERALIZED DENSITY OF STATES FUNCTION FOR NUCLEAR SPECTRA. G. C. Phillips, T. A. Griffy, and L. C. Biedenharn (Rice Univ., Houston, Tex.). Nuclear Phys., 21: 327-39 (Nov. 5, 1960). (In English)

The cluster model of the nucleus suggests that three- (or more-)body decay may be treated as a time sequence of two-body interactions. The cross section for particle emission into a spectrum of energies may be calculated if it is assumed that the reaction $a + A \rightarrow D^* \rightarrow b + C + c$ occurs as a sequence of two-body decays: $D^* \rightarrow B^* + b$; $B^* \rightarrow c + C$. If B^* is produced in a localized state of radius α and decays only via the single two-body channel $c + C$ whose phase shift is known, then the cross section for emission

of particles b is largely determined by a density of states factor $\rho = (1/\pi)d/dE_B(\delta_l(E_B) + \varphi_l(\alpha,E_B))$. This result is discussed and compared both to experiments and to other treatments of the same problem. (auth)

10018 RADIOACTIVITY DECAY OF Tm^{167}. H. Narasimhaiah and M. L. Pool (Ohio State Univ., Columbus). Nuclear Phys., 21: 340-3(Nov. 5, 1960). (In English)

Erbium oxide enriched in the mass number 167 was irradiated with 12-Mev deuterons and 6-Mev protons. An activity with a half life of 9.58 days was produced and ascribed to Tm^{167}. The spectrum consisted of Er K x radiations and γ rays of 57, 208, and 532 kev and the observed relative intensities were 100, 5.4, 56.6, and 3.18. None of the γ rays was in coincidence with another. Transition probabilities and branching ratios are shown in a proposed energy level diagram. (auth)

10019 NEUTRON CROSS SECTIONS IN CHLORINE. G. S. Mani, T. A. Tombrello, and D. A. A. S. N. Rao (Rice Univ., Houston, Tex.). Nuclear Phys., 21: 344-6(Nov. 5, 1960). (In English)

An upper limit of 5 mb was obtained for the $Cl^{37}(n,p)S^{37}$ reaction cross section at a neutron energy of 17.5 Mev. The cross section for the $Cl^{35}(n,2n)Cl^{34m}$ reaction was measured for neutron energies between 17 and 22 Mev. (auth)

10020 ISOTOPE SHIFT CALCULATIONS FOR NON-UNIFORM CHARGE DISTRIBUTIONS. A. R. Bodmer (Univ. of Manchester, Eng.). Nuclear Phys., 21: 347-52 (Nov. 5, 1960). (In English)

It is shown that recent calculations of the charge dependent isotope shift by Meligy for the special case of a trapezoidal nuclear charge distribution are in agreement with previous results, which are applicable to any charge distribution whatever its shape, both sets of calculations allowing for the distortion of the electron wave function by the nuclear charge distribution. A discussion of Meligy's numerical results is given which indicates that previous conclusions about the isotope shift discrepancy remain essentially unchanged. (auth)

10021 AN APPROACH TO THE SYSTEMATICS OF DELAYED NEUTRON PRECURSORS. Alexis C. Pappas (Univ. of Oslo, Blindern, Norway) and Gösta Rudstam. Nuclear Phys., 21: 353-66(Dec. (1) 1960). (In English)

A review of the theory of delayed neutron emission probabilities is given, and the expectations critically surveyed. The upper Z limits of the region where delayed neutron emission is energetically favored were estimated throughout the table of nuclides and led to a systematics of delayed neutron precursors. The average distance of the delayed neutron precursor (Z,N) from the stable charge Z_{N-1} of the isotones of the delayed neutron emitter (Z + 1, N−1) i.e., $(Z_{N-1}-Z)$, increases from light to heavy nuclides. The effect of closed nucleon shells is very pronounced. Just above neutron shell edges the upper Z limit is drawn toward stability. This effect increases with higher neutron shells. (auth)

10022 GROUND STATE GAMMA TRANSITIONS FROM STATES AT 10.09 AND 10.24 Mev IN N^{14} AND REINVESTIGATION OF THE 9.17- AND 10.43-Mev GAMMA RAY DISTRIBUTIONS. H. J. Rose, F. Riess, and W. Trost (Universität, Freiburg i. B.). Nuclear Phys., 21: 367-82(Dec. (1) 1960). (In English)

The angular distributions of the ground-state transitions from the N^{14} 9.17- and 10.43-Mev levels were reinvestigated using the reaction $C^{13}(p,\gamma)N^{14}$ at the 1.75- and 3.11-Mev resonances. From the value obtained for the anisotropy of the 9.17 ($J^\pi = 2^+$) → 0 ($J^\pi = 1^+$), transition limits on the quadrupole-dipole mixture were obtained. The 10.43-Mev state was assigned J = 2, using the results of previous investigations. From a distribution measurement limits were set on the quadrupole-dipole mixture in the 10.43 → 0 transition. A strong energy-dependent cos θ term was observed in the angular distribution of the ground-state γ rays for proton bombarding energies between 2.7 and 3.2 Mev. For this energy range the (p,γ) excitation functions were determined at angles of 0, 90, and 140° with respect to the proton beam. Additional distribution measurements were made in the neighborhood of the 3.11-Mev resonance. The theoretical fits of these data present evidence that the cos θ term mainly arises from interference between the 10.43-Mev level and "non-resonant background" caused by the "long tailed" 0.55-Mev resonance corresponding to the 8.06-Mev, $J^\pi = 1^-$, T = 1 state. In as much as this explanation of the cos θ term is likely, the 10.43-Mev level must have even parity. Rather marked variations of the strength of the cos θ term at proton bombarding energies of 2.75 and 2.90 Mev showed the presence of levels at 10.09- and 10.24-Mev excitation energy in N^{14} which decayed extremely weakly to the ground state. The 10.09-Mev state was also clearly observed in the excitation functions. Estimates of the total widths and γ widths of both these states were obtained from the excitation functions. Gamma rays from states at 10.09 and 10.24 Mev were not reported previously. (auth)

10023 THE ELASTIC SCATTERING OF 160 Mev PROTONS FROM LITHIUM, ALUMINIUM, INDIUM AND GOLD. A. Johansson (Univ. of Uppsala), G. Tibell, K. Parker, and P. E. Hodgson. Nuclear Phys., 21: 383-92(Dec. (1) 1960). (In English)

The differential cross sections and asymmetries of protons scattered elastically from lithium, aluminum, indium, and gold were measured in the angular range 3 to 30°. The results were compared with calculations using the optical model, and over-all agreement was found. (auth)

10024 THE HALF-LIFE OF THE FIRST EXCITED STATE OF Tl^{203}. E. C. B. Pederson and R. E. Bell (McGill Univ., Montreal). Nuclear Phys., 21: 393-6(Dec. (1) 1960). (In English)

The half life of the 279-kev excited state of Tl^{203} was measured from the logarithmic slope of a delayed coincidence curve. This method is preferable to the centroid shift method, which was used for previous delayed coincidence measurements, since it is much less sensitive to systematic effects and to drifts in the apparatus. The half life was found to be $T_{1/2} = (2.41 \pm 0.10) \times 10^{-10}$ sec, in agreement with previous results from resonance fluorescence but in moderate disagreement with most recent Coulomb excitation results. (auth)

10025 SHELL MODEL CALCULATIONS FOR MASS 12 NUCLEI, PERTINENT TO A TEST OF THE CONSERVED VECTOR CURRENT THEORY. Hans A. Weidenmüller (California Inst. of Tech., Pasadena). Nuclear Phys., 21: 397-405(Dec. (1) 1960). (In English)

Results of shell-model calculations are reported, which determine whether two proposed experiments with mass 12 nuclei serve as good tests of the conserved vector current theory of β decay. The measurement of the β spectra in the decays of B^{12} and N^{12} to the ground state of C^{12} seems to give a very good test of the conserved vector current theory. Calculations are reported for various transition probabilities within the mass 12 nuclei: those involving the first excited state of C^{12} are in poor agreement with experiment. (auth)

10026 LEVELS IN Th^{228} EXCITED IN THE ELECTRON CAPTURE DECAY OF Pa^{228}. E. Arbman, S. Bjørnholm, and O. B. Nielsen (Univ. of Copenhagen and Univ. of Uppsala). Nuclear Phys., 21: 406-37(Dec. (1) 1960). (In English)

Pa^{228} (22h) was produced by (p,5n) reactions on Th^{232}. The decay was studied by means of a double-focusing high-resolution β spectrometer, a six-gap high-transmission β spectrometer, scintillation spectrometers, and coincidence techniques. More than 200 conversion lines were found. Of these, 153 were ascribed to the Pa^{228} decay on the basis of their half lives and assigned to 72 γ transitions in Th^{228}. Numerous coincidence relations between conversion lines and γ rays were measured. A decay scheme comprising 22 excited states, ranging from 57.5 to 1943 kev, is presented and discussed with respect to the quantum numbers (K, I, π). In addition to the ground-state rotational band, the level structure indicates the presence of 3 or 4 rotational bands, built on intrinsically excited states. The possible collective vibrational character of the lower lying intrinsic states is discussed. Theoretical branching ratios and selection rules associated with the quantum number K are compared with experiment and discussed. (auth)

10027 THE DECAY OF NEPTUNIUM-238. R. G. Albridge and J. M. Hollander (Univ. of California, Berkeley). Nuclear Phys., 21: 438-49(Dec. (1) 1960). (In English). (UCRL-8034)

A study was made of the energy levels of Pu^{238} which are populated by Np^{238} β decay, by an examination of the Np^{238} conversion electron spectrum in high-resolution β spectrographs. The general features of the level scheme as previously given were unchanged but several new transitions were observed, with energies of 119.8, 871, 943, 989, and 1034 kev. Two new levels are postulated at 915 and 1034 kev which accommodate all but the 943-kev transition. A possible assignment of the 943-kev transition to the (0+,0) state of the β vibrational band is discussed. In addition, the weak 885-kev transition from the 2+ state of the γ-vibrational band to the 4+ state of the ground band was seen and its relative intensity determined. Comparisons were made of the experimental relative transition intensities of the three photons depopulating this band with those predicted from the rules of Alaga et al.; only fair agreement was noted. A discussion is given of the β decay branchings and log ft values of Np^{238} decay in terms of the postulated characters of the Pu^{238} states and the measured spin of Np^{238}. (auth)

10028 GAMMA-GAMMA ANGULAR CORRELATIONS IN Rh^{103}. B. P. Singh (Muslim Univ., Aligarh, India). Nuclear Phys., 21: 450-5(Dec. (1) 1960). (In English)

The angular correlations of γ rays in Rh^{103} were studied for the 555−55- and 440−55-kev cascades. The following correlation functions were obtained for the 555−55-kev cascade: $W(\theta) = 1-(0.152 \pm 0.011)P_2(\cos\theta)-(0.042 \pm 0.017)P_4(\cos\theta)$, and for the 440−55 kev cascade: $W(\theta) = 1 + (0.049 \pm 0.013)P_2(\cos\theta)-(0.016 \pm 0.017)P_4(\cos\theta)$. The spins of the excited levels 650, 535, and 95 kev in Rh^{103} are discussed in the light of these correlation studies. The various possibilities of the spin values for these levels are summarized. (auth)

10029 IMAGINARY PART OF THE OPTICAL MODEL POTENTIAL IN NUCLEAR MATTER. J. Sawicki (Univ. of California, Berkeley) and S. A. Moszkowski. Nuclear Phys., 21: 456-61(Dec. (1) 1960). (In English)

The imaginary part of the optical model potential in nuclear matter was calculated for various values of the energy, assuming Gammel-Thaler nucleon-nucleon interactions. The calculations were made using the separation method in which the interaction is separated into short- and long-range parts, the former giving zero phase shift. To a good approximation, only the long-range component contributes to the imaginary part of the optical potential. (auth)

10030 SELECTION RULES AND CORRELATIONS FOR POLARIZATION IN STRIPPING AND DIRECT PROCESSES. L. J. B. Goldfarb and R. C. Johnson (The University, Manchester, Eng.). Nuclear Phys., 21: 462-73(Dec. (1) 1960). (In English)

Various selection rules for polarization and correlations between effects of incoming polarization and the polarization arising from unpolarized incoming beams were found for a variety of direct nuclear processes. Use was made of the distorted-wave Born approximation, with allowance made for spin-dependent distortion. The results were found without explicit evaluation of the parameters that are involved, but with attention given to the separate effects of the assumptions of parity conservation and the invariance of the interaction under time-reversal. (auth)

10031 A METHOD FOR THE ELIMINATION OF SPURIOUS STATES IN THE NUCLEAR HARMONIC OSCILLATOR SHELL MODEL. B. J. Verhaar (Universiteit, Amsterdam). Nuclear Phys., 21: 508-25(Dec. (1) 1960). (In English)

A group-theoretical method was used for the nuclear eigenstates in the harmonic oscillator shell model. This classification is intimately connected with the distinction between good and spurious states. It provides a procedure for the elimination of spurious states. The method makes use of the invariance properties of the system hamiltonian for several groups of transformations. In particular a group U_3 formerly used for the study of collective rotational effects in the nuclear shell-model is of importance. This group is related to the degeneracy of the 3-dimensional isotropic harmonic oscillator states. Some special examples, illustrating the method, are given. (auth)

10032 RESONANCES IN THE REACTIONS Si^{28} + p. J. O. Newton (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Phys., 21: 529-41(Dec. 3, 1960). (In English)

Resonances in the γ-ray yield were observed at bombarding energies of 1.653 ± 0.005, 2.09 ± 0.015, and 2.30 ± 0.015 Mev. They correspond to energy levels in P^{29} at 4.320 ± 0.015, 4.74 ± 0.022, and 4.94 ± 0.022 Mev with total observed widths of 55.2 ± 2, 14 ± 2, and less than 4 kev, respectively. Capture γ radiation proceeding predominantly to the ground state of P^{29} was observed from the two lower resonances. The 4.94 Mev resonance showed only radiation corresponding to that from the first excited state of Si^{28}. The angular distribution of the γ rays at the 1.65-Mev resonance shows that the 4.320 Mev state has spin $\frac{3}{2}$. Considerations of reduced widths indicate that it has odd parity and is of the "single particle" type. Strong interference effects were observed in the angular distributions at off resonant energies. It seemed likely that this interference occurs mainly with the hard sphere part of the direct electric dipole capture process. A cross section of (1.3 ± 0.4) μ barns was obtained for this process at 1.65-Mev bombarding energy on the assumption that all of the interference arises from this source. A value of 1.75 ± 0.35 ev was obtained for the radiative width Γ_γ of the 4.320-Mev state. The angular distribution of the γ rays at the 2.09-Mev resonance was also shown to be anisotropic, but the anisotropy may still be consistent with the previously reported spin of $\frac{1}{2}$ + for the 4.74-Mev

state. A value of 0.9 ± 0.4 ev was obtained for the radiative width $(2J + 1)\Gamma_\gamma$ of this state. (auth)

10033 COULOMB ENERGIES OF MIRROR NUCLEI. S. Sengupta (Mohsin Coll., Hooghly, West Bengal, India). Nuclear Phys., 21: 542-54(Dec. 3, 1960). (In English)

A semiclassical expression for Coulomb energies of the mirror nuclei was developed. The exchange part in the expression was derived on a statistical model that gives, in addition to the usual term, a pairing effect of magnitude 0.33. Inconsistencies in some of the earlier expressions are pointed out. The radius parameter r_0 from this formula agrees very well with the electron scattering values. A more detailed calculation of the Coulomb energies in LS-coupling shell model with constant values of the parameters within a shell gave least squares fit with an r.m.s. deviation of nearly 4% in both p and d-s shells. The least squares fit parameters were not satisfactorily reproduced by the harmonic oscillator wave function. The variation of the harmonic oscillator strength parameter $\alpha = \sqrt{\omega M/\hbar}$ within p and d-s shell was studied. A comparison of the r.m.s. radius from Coulomb energies and electron scattering showed a discrepancy of about 8% in case of Be^9. The vanishing of the second difference of Coulomb energy and its negative value at a shell crossing were found to agree with the detailed shell model calculation. (auth)

10034 REACTION MECHANISM STUDIES ON $Si^{28}(d,p)Si^{29}$. II. INTERFERENCE EFFECTS. J. A. Kuehner, E. Almqvist, and D. A. Bromley (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nuclear Phys., 21: 555-81(Dec. 3, 1960). (In English)

Measurements bearing upon the mechanism for the $Si^{28}(d,p)Si^{29}$ reaction, including measurements of differential and total excitation functions and of angular distributions for the proton groups leading to the lowest three states of Si^{29}, were made for incident deuterons of energy 6 to 10.7 Mev and for proton detector angles 0 to 155°. These measurements demonstrated a dominant direct interaction amplitude, with, however, a small residual compound system amplitude reflected in interference terms in the cross section. The effects of this interference were displayed by prominent resonance structure in the excitation curves, particularly for proton angles off the forward stripping peak. Upper limits of < 15 and < 30% were established for the intensity of the compound system contributions to the reaction cross sections to the ground state and first two excited states of Si^{29}, respectively. Angular distributions were found to have similar features over the energy range studied and to display diffraction structure which persisted even at large angles. The angular positions of the structural features were well fitted by Butler theory but with the observed envelope decreasing much less rapidly with angle than does the prediction. Empirically it was demonstrated that adequate fits are obtained by removing the angle dependence contained in the deuteron factor that appears in the Butler expression for the angular distribution. Reduced widths were obtained using the methods of Amado and of Bowcock. A comparison of these reduced widths with values obtained by the usual peak-fitting technique demonstrated that the same relative reduced widths are given by the three methods but that the absolute value obtained using the Amado extrapolation is approximately a factor of two less than that obtained with the other two techniques. (auth)

10035 ENERGY OF A LOW DENSITY NEUTRON GAS. P. C. Sood and S. A. Moszkowski (Univ. of California, Los Angeles). Nuclear Phys., 21: 582-94(Dec. 3, 1960). (In English)

The energy of a neutron gas was calculated in the low density limit using the singlet S state shift corresponding to the Gammel-Thaler potential. The corrections to this energy were evaluated, assuming a factorable interaction (i.e., a separable potential). The correction due to the Pauli exclusion principle and the pairing correction, (i.e., depression of the ground state energy due to pair correlations, which is similar to that in the theory of superconductivity) were calculated. It was concluded that a pure neutron gas is unbound even at very low densities. (auth)

10036 HYPERNUCLEI PRODUCED BY K^- INTERACTIONS IN NUCLEAR EMULSIONS. I. MESIC DECAYS. Milan M. Nikolić (Universität, Bern). Nuclear Phys., 21: 595-8(Dec. 3, 1960). (In English)

Two and nine hypernuclei decaying according to the π^- mesic mode were found in examining 415 K^- interactions in flight and 1104 K^- absorptions at rest, respectively. Nine of these hypernuclei were uniquely identified while for the remaining two there are more possible interpretations. (auth)

10037 HYPERNUCLEI PRODUCED BY K^- INTERACTIONS IN NUCLEAR EMULSIONS. II. GENERAL CHARACTERISTICS AND NON-MESIC DECAYS. V. Georgé, W. Koch, W. Lindt, M. Nikolić, S. Subotić-Nikolić, and H. Winzeler (Universität, Bern). Nuclear Phys., 21: 599-623(Dec. 3, 1960). (In English)

Sixty possible hypernuclei produced in 1104 K^- interactions at rest and 415 K^- interactions in flight, were analyzed. The hypernucleus charge distribution was determined and the non-mesic to π^- mesic ratio was given as a function of the hyperfragment charge. The stimulated decay was discussed. The hypernucleus formation probability was estimated. (auth)

10038 COULOMB EXCITATION WITH 14-20 MEV α-PARTICLES: DOUBLE EXCITATIONS AND SYSTEMATICS OF VIBRATIONAL STATES IN THE RARE EARTH REGION. O. Nathan and V. I. Popov (Univ. of Copenhagen). Nuclear Phys., 21: 631-51(Dec. 3, 1960). (In English)

An exploratory investigation of nuclei in the rare-earth region was performed by means of the Coulomb excitation process, using 14 to 20 Mev α particles as projectiles and studying the deexcitation γ rays. Rotational double excitations were systematically observed in deformed even nuclei, and evidence for double E2-E2 excitations was also found in some nonrotational even nuclei. In single excitation a number of γ rays were seen which have not been reported previously in Coulomb excitations, and approximative values for the corresponding partial reduced E2 transition probabilities eB(E2) were determined. Tentative level schemes are proposed which will explain the observations, and the nature of the excited states is discussed on the basis of the measured eB(E2) values. In particular, it is pointed out that these results, together with other data, may indicate the presence of γ vibrations in Ho^{165} and some other deformed nuclei with odd number of protons. (auth)

10039 ELASTIC SCATTERING AND RADIATIVE CAPTURE OF PROTONS BY C^{13}. D. F. Hebbard and J. L. Vogl (California Inst. of Tech., Pasadena). Nuclear Phys., 21: 652-75(Dec. 3, 1960). (In English)

Measurements of the elastic scattering of protons by C^{13} from 140 to 750 kev proton energy are reported. The radiative capture of protons by C^{13} was investigated down to a proton energy of 130 kev, but no new levels were found that would influence the cross section at stellar energies. The only new level found had a resonance energy of 448.5 ± 0.5 kev. An upper limit is placed on the strength of radiative capture by any missed levels. Angular distribution measurements, combined with the results of $N^{14}(\alpha,\alpha')$ by other work-

ers led to an assignment $J^{\pi} = 2^{-}$ for the 448-kev resonance (7.966-Mev excitation). From the same target used for the $C^{13}(p,\gamma)$ measurements, the yield of $C^{12}(p,\gamma)$ radiation was measured, and the cross sections of both reactions are extrapolated to stellar energies. The extrapolated cross section factor S_0 at 25-kev C.M. proton energy is 6.0 ± 0.8 kev-barn for the $C^{13}(p,\gamma)$ reaction and is 1.33 ± 0.15 kev-barn for the $C^{12}(p,\gamma)$ reaction. The equilibrium ratio by number of C^{12}/C^{13} in the CNO-cycle is thus 4.1 ± 0.7 at a temperature of 15×10^6 °K. (auth)

10040 THE MOMENTUM DISTRIBUTION IN A DILUTE FERMI GAS AT ZERO TEMPERATURE. W. Czyz and K. Gottfried (Univ. of Copenhagen). Nuclear Phys., 21: 676-80(Dec. 3, 1960). (In English)

The momentum distribution at zero temperature in a dilute Fermi gas with repulsive interactions was calculated to the second order in the small parameter $p_F a$, the quantity p_F being the Fermi momentum and a the free-space scattering length. (auth)

10041 n–p POLARIZATION AND LOW ENERGY p–p PHASE SHIFTS. R. J. N. Phillips (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Phys., 21: 686-7(Dec. 3, 1960). (In English)

It is argued that n–p polarization at 90° c.m. depends only on T = 1 phase shifts to a fair approximation over a range of low energies. Assuming charge independence, this helps to determine p–p phase shifts. (auth)

10042 COULOMB EXCITATION OF Ge^{74} AND Ge^{76}. W. R. Wisseman and R. M. Williamson (Duke Univ., Durham, N. C.). Nuclear Phys., 21: 688-95(Dec. 3, 1960). (In English)

Deuterons and protons with energies from 3.5 to 4.0 Mev were used to excite the 598 kev level in Ge^{74} and the 564 kev level in Ge^{76}. The scattered particles were studied at angles from 75 to 150° with a magnetic analyzer by using photographic plate detection. The applicability of Coulomb excitation theory in this region of atomic number and incident energy was tested by measuring the energy dependence of the deuteron excitation cross sections for both nuclei, the angular distribution of inelastically scattered deuterons for Ge^{74}, and the ratios of the deuteron to the proton excitation cross sections. These data indicate that Coulomb excitation theory may be applied for deuterons of less than 3.5 Mev and protons of less than 4.0 Mev. The values of the reduced transition probability, B(E2), of Ge^{74} and Ge^{76} are 0.32 ± 0.03 and 0.29 ± 0.03, respectively. The B(E2) value derived from 4.0-Mev deuteron data for Ge^{74} was 30% higher than the above value. Part of this discrepancy may be due to departures from Rutherford scattering of the elastically scattered deuterons since Rutherford scattering was assumed in deriving the inelastic cross sections. (auth)

10043 THE DIPOLE STATE IN NUCLEI. G. E. Brown, L. Castillejo, and J. A. Evans (Univ. of Birmingham, Eng.). Nuclear Phys., 22: 1-13(Jan. 1961). (In English)

The mechanism of the particle-hole interaction in producing the "dipole state," i.e., the giant dipole resonance, in nuclei is discussed in detail. Calculations in j–j coupling were carried out with zero-range forces for the nuclei O^{16} and Ca^{40}. Comparison with finite-range calculations in the case of O^{16} showed that the zero-range calculations reproduce well not only qualitative, but also most quantitative, features. In all cases, the particle-hole interaction concentrates the dipole-strength in the uppermost states, the energies of which are also shifted upward by the interaction. (auth)

10044 LONG RANGE CORRELATIONS AND PHOTO EFFECT IN NUCLEI. W. Brenig (Massachusetts Inst. of Tech., Cambridge). Nuclear Phys., 22: 14-33(Jan. 1961). (In English)

A detailed quantum mechanical treatment of the collective model for the giant dipole resonance in the low energy nuclear photo effect is presented. A relation $\omega_D = ck_D$ for the resonance energy ω_D was derived from sum rule considerations, where k_D is related to the nuclear radius by $k_D \approx \pi/2R$ and c to the structure factor s(k) of nuclear matter at small momenta k by $s(k) = k/2mc$. The velocity c was calculated and the semiclassical expression for c in terms of the symmetry energy K ($c = (2K/m)^{1/2}$) was found to be valid only for extremely strong interactions. For weaker forces a larger value of c than indicated by this relation and a value of ω_D in better agreement with the results of shell model configuration mixing calculations was obtained. (auth)

10045 POLARIZATION IN (d,p) REACTIONS. D. Robson (Univ. of Melbourne). Nuclear Phys., 22: 34-46 (Jan. 1961). (In English)

Previous treatments of the distorted wave theory in stripping were extended to include the effects of spin-orbit forces in both incident and final channels. Numerical calculations of the $C^{12}(d,p)C^{13}$ ground state reaction at 8.9 Mev incident energy using rounded optical model potentials yielded the correct sign for the polarization of the emergent protons. The inclusion of spin-orbit forces in both channels relieved the 33⅓% restriction on the size of the polarization. Polarizations as large as 70% are predicted in this way and provide a likely explanation of the large experimental polarizations. The distorted wave functions used to describe the stripping reaction are also used to predict elastic scattering angular distributions and polarizations. Good agreement was found with experiment in cases where data are available. (auth)

10046 SPIN-ORBIT EFFECTS IN THE STRIPPING REACTION INVOLVING POLARIZED PARTICLES. D. Robson (Univ. of Melbourne). Nuclear Phys., 22: 47-56 (Jan. 1961). (In English)

The theory of the stripping reaction involving polarized particles is considered. The angular distribution and polarization of the product of the stripping reaction induced by polarized particles in unpolarized nuclei were determined by the distorted wave method including spin-orbit coupling. An attempt was made to investigate the validity of stripping formulas in which spin-orbit effects are neglected. (auth)

10047 Dy^{155} AND Dy^{157} DECAY SCHEMES. K. S. Toth and O. B. Nielsen (Univ. of Copenhagen). Nuclear Phys., 22: 57-70(Jan. 1961). (In English)

The disintegration schemes of Dy^{155} and Dy^{157} were studied. In addition to obtaining conversion-electron and γ-ray spectra, e–γ coincidence measurements were made. The Dy^{157} results were conclusive and support the decay scheme proposed by Michelich, Harmatz, and Handley on the basis of differences and sums of accurately determined transition energies. The level in Tb^{157} at 327-kev is shown to be $5/2-$. The relative intensities of the three E1 γ-rays proceeding from this level to the three members of a ground rotational band based on a spin of $3/2+$ were found to agree with the corresponding branching ratios found for the analogous case in Tb^{159} involving a $5/2-$ 364-kev level and a ground rotational band again with a $3/2+$ base state. In both instances the experimental intensities disagreed with the theoretical branching ratios. The Dy^{155} coincidence results were inconclusive due chiefly to the presence of interfering activities. However, the Dy^{155} data do corroborate some features of a

disintegration scheme proposed by Toth and Rasmussen for this isotope and based on accurately measured transition energies. Also a new level in Tb^{155} at approximately 880 kev was established in the course of this investigation. (auth)

10048 INELASTIC INTERACTIONS OF π-MESONS WITH NUCLEONS AT 6.8 GeV. V. S. Barashenkov (Joint Institute for Nuclear Research, Dubna, USSR). Nuclear Phys., 22: 71-7(Jan. 1961). (In English)

The results of experiments with π mesons are compared with the calculations by the statistical theory. Good agreement was observed in the distribution of stars with number of prongs and with momentum of the particles produced. Peripheral collisions were taken into account to explain angular distributions. Experimental data could be brought into agreement with the theory under the assumption that the cross section of peripheral collisions accounts for more than half of the total cross section of all inelastic processes. The resonant interaction of π mesons is discussed. (auth)

10049 VIBRATIONAL STATES OF NUCLEI IN THE RANDOM PHASE APPROXIMATION. D. J. Thouless (Univ. of Copenhagen). Nuclear Phys., 22: 78-95(Jan. 1961). (In English)

The properties of those states which can be obtained by exciting a single particle from the ground state of a nucleus were studied by using a perturbation-theory expansion for Green's function. The formula obtained differs from the one used in a straightforward shell model calculation in some important respects. By comparing this formula with the condition for a solution of the Hartree-Fock equations to give a minimum of the expectation value of the energy, derived in an earlier paper, it is shown that it is always possible to choose an independent particle wave function which makes all collective modes stable in the random phase approximation. A study of the formal properties of solutions of the equation shows that the wave functions should be normalized using an indefinite metric: different eigenfunctions are then orthogonal. The eigenfunctions form a complete set, if there is no degeneracy in the solution of the Hartree-Fock equations, but not if there is a degeneracy. An upper bound for the lowest energy level is established, and the rule for calculating matrix elements of one-particle operators between the ground state and an excited state is given. It is shown to follow from the self-consistent field condition that the energy-weighted sum rules are preserved in this approximation. A discussion of spurious states is given, and it is shown that they separate out and have zero energy. A vector introduced in an earlier discussion of the cranking model is shown to be independent of all eigenvectors in this case. (auth)

10050 THE $O^{16}(n,\alpha)C^{13}$ REACTION BY THE THIN CRYSTAL METHOD. N. Cindro, I. Šlaus, P. Tomas, and B. Eman (Inst. "Ruder Bošković," Zagreb). Nuclear Phys., 22: 96-100(Jan. 1961). (In English)

The angular distribution of the $O^{16}(n,\alpha)C^{13}$ reaction with 14.4-Mev neutrons was measured by using a thin crystal, whose thickness was enough to stop α particles of a given energy. Thus the use of the telescopic arrangement was avoided. The results showed a pronounced backward peaking. A theoretical fit using the "heavy particle stripping" formulas was attempted. (auth)

10051 INTERNAL CONVERSION ELECTRONS FROM COULOMB EXCITATION OF HEAVY ELEMENTS. D. H. Rester, M. S. Moore, F. E. Durham, and C. M. Class (Rice Univ., Houston, Texas). Nuclear Phys., 22: 104-30(Jan. 1961). (In English)

The spectra of internal conversion electrons due to Coulomb excited transitions in Au^{197}, the five abundant isotopes of osmium, $Th^{230,232}$, and $U^{234,236,238}$ were obtained with a β-ray spectrometer of the single-segment "orange" type. Some of the experimental problems connected with these measurements are discussed. Reduced transition probabilities were measured for the first 2^+ excited states of all the even nuclei by means of the conversion electrons. For the even isotopes of osmium, some evidence suggesting enhanced internal conversion is found. The quadrupole moments and deformation parameters derived from the reduced transition probabilities agree well with the values obtained in recent theoretical calculations. Evidence for a weak cascade transition between the well-known states at 548 and 279 kev in Au^{197} was found, and a level in Os^{189} at 69.7 kev was confirmed which is identified as the $5/2^-$ first excited rotational state. Two weak conversion lines in the osmium spectrum believed to be contributed by Os^{189} were assigned the probable transition energies of 194 and 245 kev. (auth)

10052 HIGHER-ORDER EFFECTS IN AN ALLOWED POSITON DECAY IN Co^{56}. B. G. Pettersson, J. H. Hamilton, and J. E. Thun (Univ. of Uppsala). Nuclear Phys., 22: 131-7(Jan. 1961). (In English)

The allowed positon decay of Co^{56} to the second excited state of Fe^{56} has the unusually large log ft value of 8.7. A study of the directional correlation of this positon group with the two cascade γ rays of energy 0.85 and 1.24 Mev which depopulate this level was measured as a function of β energy from 0.7 to 1.2 Mev to yield new information about the decay to this level. A magnetic spectrometer was used as the β analyzer. An anisotropic correlation was measured, $A_{max} = (2.5-3.3)$ % near 1.2 Mev. This is only the third case where any correlation was observed in an allowed β decay and it is much larger than the other two. An explanation may be found in higher order terms predicted by the Gell-Mann theory or in terms of cross terms between allowed and second forbidden matrix elements. Better theoretical calculations are needed, especially for large ft decays, before theory and experiment can be compared favorably. (auth)

10053 THE ELASTIC SCATTERING OF 19.5 MEV DEUTERONS BY KRYPTON. P. E. Hodgson (Clarendon Lab., Oxford), J. Aguilar, A. García and J. B. A. England. Nuclear Phys., 22: 138-44(Jan. 1961). (In English)

Experimental elastic differential cross sections for the scattering of 19.5-Mev deuterons by krypton in the range 13 to 90° in the center-of-mass system were measured using a nuclear emulsion plate camera. The results are compared with calculations based on the optical model of the interaction. (auth)

10054 THE GYROMAGNETIC RATIO OF THE 80 keV ROTATIONAL STATE OF ERBIUM 166. E. Bodenstedt, H. J. Körner, C. Günther, and J. Radeloff (Universität, Hamburg). Nuclear Phys., 22: 145-56(Jan. 1961). (In English)

The angular correlation of the (1380 kev)−(80 kev) γ−γ cascade in the decay of 27 hr Ho^{166} was measured in an external magnetic field of 13,550 G. The observed rotation yields for the nuclear g-factor of the 80-kev 2+ rotational state was $g_R = +0.260 \pm 0.034$. A paramagnetic correction factor of $\beta = 8.36$ ($B_{eff} = \beta B_{ext}$) was applied in the calculation of this value. There was a strong attenuation of the (1380 kev)−(80 kev) angular correlation by internal fields. The attenuation factors for a liquid source of $HoCl_3$ in aqueous solution were determined as $G_2 = 0.80 \pm 0.08$ and $G_4 =$

0.56 ± 0.04. A measurement of the (1380 kev)−(80 kev) angular correlation for different delays showed agreement with a time dependent attenuation $A_k(t) = A_k(0)\, e^{-\lambda_k t}$, where the λ_k are $\lambda_2 = 0.09 \times 10^9$ sec^{-1} and $\lambda_4 = 0.30 \times 10^9$ sec^{-1}. The ratio of λ_4/λ_2 suggests that the attenuation is caused mainly by magnetic interaction between the 4f electron shell and the magnetic moment of the nucleus. The spin relaxation time for the 4f electron shell was calculated as $\tau J = (3.4 \pm 0.9) \times 10^{-13}$ sec. (auth)

10055 SPURIOUS STATES ARISING FROM THE CENTRE-OF-MASS MOTION OF A NUCLEUS. Elizabeth Baranger and Chong Wan Lee (Univ. of Pittsburgh). Nuclear Phys., 22: 157-63(Jan. 1961). (In English)

A simple method is given for generating the spurious states which arise from the incorrect treatment of the center-of-mass motion by nuclear shell model calculations. It is not necessary to know the spurious states to find their weight in a particular shell model state. It is also shown which jj configurations have no spurious states. Some examples are given. (auth)

10056 ISOSPIN FOR $N + \overline{N} \rightarrow K + \overline{K} + k\pi$ AND SIMILAR REACTIONS. H. Pilkuhn (Univ. of Stockholm). Nuclear Phys., 22: 168-76(Jan. 1961). (In English)

For antiproton annihilation into a $K\overline{K}$ pair and k pions and for multiple pion production in nucleon-nucleon and pion-nucleon collisions, the transition rates into states with given charge configurations of the outgoing particles are expressed in terms of isospin amplitudes. For the pions' states, representations of the permutation group are employed. Interference terms are discussed, and explicit expressions are given for k up to 5. (auth)

10057 NATURAL ABUNDANCES OF Er^{172} AND Yb^{167}. P. S. Baker and T. L. Collins (Oak Ridge National Lab., Tenn. and Knolls Atomic Power Lab., Schenectady, N. Y.). Nuclear Sci. and Eng., 9: 98-9(Jan. 1961).

During recent electro-magnetic collections of erbium and ytterbium isotopes, collector pockets were inserted at the Er^{172} and Yb^{167} positions to check for the possible natural existence of those isotopes. Mass spectrometric analyses of the purified product showed new limits of <0.000008 and <0.00001 at.%, respectively. This indicated that the limits of natural abundance would be <0.0000008 and <0.000001 at.% of Er^{172} and Yb^{167}. (M.C.G.)

10058 PRECISION MEASUREMENTS OF THE SLOW NEUTRON ABSORPTION CROSS SECTIONS OF NORMAL BORON STANDARDS. G. J. Safford, T. I. Taylor, B. M. Rustad, and W. W. Havens, Jr. (Columbia Univ., New York and Brookhaven National Lab., Upton, N. Y.). Nuclear Sci. and Eng., 9: 99-100(Jan. 1961).

The total neutron cross section for four different samples of normal boron was measured at neutron energies between 0.00291 and 0.1 ev. The absorption cross section was obtained by subtracting the relatively small known scattering cross section. The B^{10} content of three of the samples was measured with a mass spectrometer. Values of 764 ± 3, 761 ± 3, 764 ± 3, and 762 ± 3 barns were obtained for the four samples. (M.C.G.)

10059 THE GAMMA-ALPHA REACTION IN TELLURIUM. F. I. Havliček (J. Stefan Institut, Lijumljana, Yugoslovia). Nuovo cimento (10), 18: 65-9 (Oct. 1, 1960). (In German)

Alpha particle tracks were measured in telluric acid-treated Ilford $E-{}^{1}/_{200}$ emulsion plates which had been irradiated with bremsstrahlung of a maximum energy of 33 Mev. An unexpectedly high number of α particles was observed. Also the angular dependence of the orientation of the tracks was determined and compared with measurements of other elements. (tr-auth)

10060 ELECTRON SCATTERING BY THIN FOILS FOR ENERGIES BELOW 10 kev. H. Kanter (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 121: 461-71(Jan. 15, 1961).

The transmission (η_T) of electrons through thin films of C, Al_2O_3, Al, Ni, Ag, and Au, together with their distribution in angle and energy, were measured in a spherical retarding-potential analyzer. The distributions were characterized by average and most probable scattering angle, average and most probable fractional energy loss, etc. The dependence of these variables on initial energy (E_p), film thickness, and material was investigated. For sufficient film thickness, the transmitted energies, the scattering angles, and η_T can be represented as universal functions of the reduced energy, E_p/E_c, where E_c is the critical E_p for the onset of transmission. Direct relations exist between η_T, scattering angles, and energy losses for the complete range of scattering from small-angle scattering to total diffusion. The dependence of η_T and average fractional energy loss on Z is consistent with published results on backscattering coefficient and energy loss for thick layers. An estimate of the mean free path for inelastic collisions proves to be in good agreement with the predictions of the Bohr-Bethe theory. Range-energy relations are almost independent of Z when the range is measured in mass per unit area. (auth)

10061 ISOTOPE SHIFTS IN THE SPECTRA OF Mo AND Ru. R. H. Hughes (Univ. of Arkansas, Fayetteville). Phys. Rev., 121: 499-500(Jan. 15, 1961).

Isotope shifts in several lines showing shifts in the field-effect direction in the spectra of molybdenum and ruthenium were studied with the aid of a Fabry-Perot interferometer. The variations in the shifts were quite similar in the two elements. A distinct minimum shift between the even-even nuclei occurred at neutron number 56. Extreme even-odd staggering inverted the expected order of the atomic levels belonging to nuclei with neutron numbers 54 and 55. The variations in the shifts were qualitatively predicted by the nuclear deformations as measured by Coulomb excitation, particularly in the case of molybdenum. (auth)

10062 RANGES AND RANGE STRAGGLING OF Tb^{149}, At, AND Po. Lester Winsberg and John M. Alexander (Univ. of California, Berkeley). Phys. Rev., 121: 518-28 (Jan. 15, 1961).

Ranges and range straggling of recoils from nuclear reactions induced by the ions C^{12}, N^{14}, O^{16}, O^{18}, and Ne^{22} with kinetic energies of 10 Mev per nucleon and less are reported. Range-energy curves were obtained for Tb^{149} (recoil energies of 4 to 29 Mev) in Al, for At and Po (4 to 15 Mev) in Al, and for At and Po (4 to 9 Mev) in Au. Ranges of Tb^{149} at the threshold of each reaction were obtained by extrapolation. The agreement of these and the directly measured values support the assumption of compound-nucleus formation used in calculating the recoil energies. The smaller recoil velocities in this study are of the same order as the Bohr velocity (2.2×10^8 cm/sec). The values of the average range and the straggling parameter are compared with stopping theory. The contribution to the measured range straggling from the nuclear reaction is discussed. These results and others were used to obtain values of the range for Xe^{139} in Al from 0.1 to 70 Mev and for At^{203} in Au from 0.01 to 10 Mev. (auth)

10063 RECOIL STUDIES OF NUCLEAR REACTIONS INDUCED BY HEAVY IONS. John M. Alexander and Lester

Winsberg (Univ. of California, Berkeley). Phys. Rev., 121: 529-37(Jan. 15, 1961). (UCRL-9118)

The mechanism of nuclear reactions induced by heavy ions was investigated by measuring the recoil ranges of Tb^{149}, At^{211}, and other α emitting isotopes of At and neighboring elements and by determining the cross sections for the formation of Tb^{149} and At^{211}. Recoil ranges were consistent with compound-nucleus formation at all energies studied for the following reactions: $Pr^{141}(C^{12},4n)Tb^{149}$, $Ce(N^{14},xn)Tb^{149}$, $La^{139}(O^{18},6n)Tb^{149}$, $La^{139}(O^{18},8n)Tb^{149}$, and $Ba(Ne^{22},pxn)Tb^{149}$. A similar result was obtained for the reaction $Pr^{141}(O^{16},2p6n)Tb^{149}$ at 138 and 146 Mev and for the reactions $Au^{197}(O^{16},2pxn$, and $3pxn)At$, Po at energies below 100 Mev. The excitation functions of the $(HI,xn)Tb^{149}$ reactions seemed to be characteristic of an evaporation process but had smaller peak cross sections than did the excitation functions of the reactions $Ba(Ne^{22},pxn)Tb^{149}$ or $Pr^{141}(O^{16},2p6n)Tb^{149}$. It was concluded that most reactions probably involve charged-particle emission. The reaction $Ba(Ne^{22},pxn)Tb^{149}$ seemed to occur with much greater probability than the reaction $Ba(Ne^{20},pxn)Tb^{149}$. In many cases the compound-nucleus mechanism could not account for the results. Partial momentum transfer was observed in the reactions $Au^{197}(O^{16},2pxn$, and $3pxn)At$, Po at energies above 100 Mev. Partial momentum transfer also occurred when Bi was bombarded at energies 1.3 times the barrier energy or greater. Reactions of Bi with heavy ions (Ne^{20} is a possible exception) at energies near the Coulomb barrier produced At^{211} with greater recoil energy than expected from a compound-nucleus mechanism. Apparently particles were emitted in the backward direction. Near the barrier the cross section for the production of At^{211} by C^{12}, O^{16}, and Ne^{20} bombardment comprised about one-fourth the value calculated for compound-nucleus formation. Therefore, the cross section for all noncompound-nucleus reactions must comprise a large fraction of the total interaction cross section. The experiments with Pb as a target were also consistent with this conclusion. (auth)

10064 GAMMA-RAY CORRELATIONS FROM THE REACTION $B^{10}(d,p)B^{11}$. Walter Reichelt and George E. Owen (Johns Hopkins Univ., Baltimore). Phys. Rev., 121: 547-52 (Jan. 15, 1961).

The $B^{10}(d,p)B^{11}$ reaction was studied at a deuteron bombarding energy of 1.2 Mev. Angular distributions and proton-gamma correlations associated with transitions to the first and second excited states of B^{11} were obtained. An analysis including the effects of heavy-particle stripping was performed for the first excited state transition and is consistent with the observed distribution and correlation. (auth)

10065 GAMMA-RAY ANISOTROPIES FROM ORIENTED Pm^{144}. D. A. Shirley, J. F. Schooley, and J. O. Rasmussen (Univ. of California, Berkeley). Phys. Rev., 121: 558-61 (Jan. 15, 1961). (UCRL-9276)

Radioactive Pm^{144} was oriented at low temperatures in a single crystal of neodymium ethysulfate. The γ rays at 475, 615, and 695 kev were found to be anisotropic. The results confirmed the decay scheme previously proposed as well as crystal-field calculations for Pm^{+3} in this lattice. It was not possible to decide between spin 5 and 6 for Pm^{144}. Values were obtained for $|A|/k$ and $|\mu|$ of 0.0091°K and 1.68 ± 0.14 nm for I = 5 or 0.0079°K and 1.75 ± 0.14 nm for I = 6. The lowest doublet of Pm^{+3} was found to be split, presumably due to Jahn-Teller distortion. (auth)

10066 CAPTURE-GAMMA DETERMINATION OF V^{52} LEVELS. J. E. Schwäger (Univ. of California, Livermore). Phys. Rev., 121: 562-8(Jan. 15, 1961). (UCRL-5869)

Thermal-neutron capture-gamma radiations for the $V^{51}(n,\gamma)V^{52*}$ reaction were observed with a fast-coincidence scintillation spectrometer recently developed for the Livermore 1-Mw pool-type reactor. The added-neutron binding energy in V^{52} was measured as 7.30 ± 0.05 Mev, and a decay scheme was established which verifies a previously proposed $V^{51}(d,p)V^{52*}$ level scheme. Several low-energy crossover, without stopover, transitions were observed: two from the 0.78-Mev level to the ground and 0.13 levels (the latter being the more intense) but not to the 0.42 level and one from the 0.83 Mev level to the ground state only. The 0.42-Mev level made both crossover and stopover transitions to the ground and 0.13-Mev levels (the former being the stronger). Some evidence exists to suggest that the low-lying V^{52*} states arise from excitations of the $(1f_{\frac{7}{2}})^3$ proton configuration alone. (auth)

10067 CAPTURE-GAMMA DETERMINATION OF V^{51} LEVELS. J. E. Schwäger (Univ. of California, Livermore). Phys. Rev., 121: 569-80(Jan. 15, 1961). (UCRL-5868)

A fast-coincidence scintillation spectrometer was developed for thermal-neutron capture-gamma studies at the Livermore 1-Mw pool-type reactor. The added-neutron binding energy in V^{51} was measured as 11.1 ± 0.1 Mev. Cascade radiations for V^{51*} were observed and a decay scheme was established which verified a previously proposed (p,p') level scheme. Spin assignments for most of the $V^{51}(p,p')$ reported levels below 4.0 Mev are proposed and the level order for the $(1f_{\frac{7}{2}})^3$ proton configuration levels is established as $\frac{7}{2}^-$ (ground state), $\frac{5}{2}^-$, $\frac{3}{2}^-$, $\frac{11}{2}^-$, $\frac{9}{2}^-$, and $\frac{15}{2}^-$ spin with excitation energies of 0.32, 0.93, 1.61, 1.81, and 2.70 Mev, respectively. Of the various nuclear force assumptions that could be made, the short-range force approximation (δ-type interaction) and weak surface-coupling effects for V^{51*} configuration states appeared to give the best match between theory and experiment. A previous calculation using experimentally measured splittings of the j^2 configuration together with tabulated coefficients of fractional parentage gave excellent agreement with experiment. Evidence was also found for $(1f_{\frac{7}{2}}^2)_0 2p_{\frac{3}{2}}$- and $(1f_{\frac{7}{2}}^2)_0 1f_{\frac{5}{2}}$-proton single-particle levels at 2.41 and 2.55 Mev, respectively, as well as for additional low-spin states between 2.70 and 3.38 Mev which possibly represent even states resulting from excitation of a lower shell proton to give a $(1f_{\frac{7}{2}}^4)_0$ configuration plus a proton hole in the vacated shell. Experimental results suggested that the V^{51*} 20−28 core is a more rigid structure than the Ca^{43*} 20−20 core. (auth)

10068 ELASTIC SCATTERING OF ALPHA PARTICLES FROM HELIUM. J. R. Dunning, A. M. Smith, and F. E. Steigert (Yale Univ., New Haven). Phys. Rev., 121: 580-3 (Jan. 15, 1961).

The elastic scattering of α particles from helium was investigated at laboratory energies of 6.43, 6.84, and 7.78 Mev. Complete angular distributions from 20 to 90° in the center-of-mass system were obtained. Analysis of the data suggests somewhat smaller values for the D-wave phase shift than were previously reported. (auth)

10069 RADIATIVE CAPTURE OF PROTONS IN C^{13}. Ross E. Hester and W. A. S. Lamb (Univ. of California, Livermore). Phys. Rev., 121: 584-6(Jan. 15, 1961). (UCRL-6002).

An excitation curve of the $C^{13}(p,\gamma)N^{14}$ reaction was measured from 100 to 140 kev. The cross section ranged from $(7.7 \pm 1.8) \times 10^{-34}$ cm^2 at 100 kev to $(9.8 \pm 1.2) \times 10^{-33}$ cm^2 at 140 kev. The results are compared with those of previous measurements. (auth)

10070 EVIDENCE FOR COMPOUND NUCLEUS FORMATION USING (p,p') AND (α,p) SCATTERING IN NICKEL.

Raymond Fox and Richard D. Albert (Univ. of California, Livermore). Phys. Rev., 121: 587-91(Jan. 15, 1961).

Spectra for (p,p') and (α,p) reactions were obtained by bombarding nickel targets with the beam of the Livermore 90-in. cyclotron and magnetically analyzing proton emitted at 135°. These reactions were studied for several energies of incident protons between 7.8 and 11.4 Mev and of incident α between 9.65 and 12.8 Mev. When the differential scattering cross section was divided by the emitted channel energy and the black nucleus cross section for protons, results were obtained for different incident proton energies that had the same relative shape when plotted vs. excitation energy. This is strong evidence for formation of compound nucleus in these reactions. A large peak was observed in the spectrum at 4.75 Mev, an excitation energy where the level density is so high that it is difficult to attribute this peak to a single level. An anomalous peak at about this energy was previously observed for 23-Mev (p,p') scattering and 30-Mev (α,α') scattering on nickel targets by Cohen and Sweetman and Wall. Results obtained for the (α,p) spectrum are in good agreement with predictions of the statistical model of the compound nucleus, assuming a level density of the form $\exp[2(aE)^{\frac{1}{2}}]$. (auth)

10071 NUCLEAR MOMENT OF Ce^{137m} BY NUCLEAR ALIGNMENT. J. N. Haag, C. E. Johnson, D. A. Shirley, and D. H. Templeton (Univ. of California, Berkeley). Phys. Rev., 121: 591-4(Jan. 15, 1961). (UCRL-9299)

Nuclei of Ce^{137} and Ce^{137m} were aligned at low temperatures in a single crystal of neodymium ethylsulfate nonhydrate by means of the magnetic hfs coupling with the electrons of the Ce^{+3} ions. The anisotropy of their γ radiation was observed. The magnetic moment of Ce^{137m} is $|\mu_N| = 0.96 \pm 0.09$ nm. The spin of Ce^{137m} is established as $^{11}/_{2}$. (auth)

10072 NEUTRON-PROTON PAIRING INTERACTION. A. N. Saxena (Stanford Univ., Calif.). Phys. Rev., 121: 595-9(Jan. 15, 1961).

The neutron-proton pairing interaction λ between the last odd neutron and the last odd proton in the outermost neutron and proton shells of an odd-odd nucleus was estimated from nuclear masses in the regions just beyond Z = 20, N = 20, and just beyond Z = 40, N = 50. Behavior of λ in these two regions and in the heavy element region Z > 82, N > 126, as estimated by Ghoshal and Saxena, is discussed. It was found that the behavior of λ may be understood in terms of a simple jj-coupling shell model. According to this model, λ arises from the spin-independent part of the two-body force and is proportional to $(2j_1 + 1 - 2z)(2j_2 + 1 - 2n)$, where z is the odd number of protons in the outermost proton shell j_1 and n is the odd number of neutrons in the outermost neutron shell j_2 of the odd-odd nucleus. (auth)

10073 COMPARISON OF THE REACTIONS $A^{36}(d,p)A^{37}$ AND $A^{36}(d,n)K^{37}$. S. S. Yamamoto and F. E. Steigert (Yale Univ., New Haven). Phys. Rev., 121, 600-5(Jan. 15, 1961).

The mirror reactions $Ar^{36}(d,p)Ar^{37}$ and $Ar^{36}(d,n)K^{37}$ were studied at 3.85-Mev bombarding energy. In the first, Q values of 6.55, 5.16, 4.92, 3.98, and 3.00 Mev were observed. The stripping distributions may be described in terms of l_n values of 2, 0, 2, 2, and 2, respectively. In the second, Q values of −0.32 and −1.78 Mev were observed. The former followed an $l_p = 2$ angular distribution. The latter could be described by a sum of $l_p = 0$ and $l_p = 2$ distributions, suggesting an unresolved doublet. (auth)

10074 SLOW-NEUTRON SCATTERING CROSS SECTIONS OF TERBIUM, YTTERBIUM, AND LUTETIUM. Masao Atoji (Ames Lab., Ames, Iowa). Phys. Rev., 121: 610-12(Jan. 15, 1961). (IS-152)

The coherent neutron-scattering cross sections of terbium, ytterbium, and lutetium as determined from the neutron diffraction measurements on TbC_2, YbC_2, Yb, and Lu metals were found to be 7.2 ± 0.4, 20.0 ± 0.4, and 6.70 ± 0.37 barns, respectively, all with amplitude of positive phase. The total scattering cross sections of Tb, Yb, and Lu and the magnetic scattering cross sections of Tb^{+3} Yb^{+3} were evaluated for thermal neutron energies. The neutron diffraction data also showed the Debye temperatures of Yb and Lu metals to be 109 ± 5°K and 161 ± 7°K, respectively. (auth)

10075 (d,p) REACTION ON HEAVY ELEMENTS AT LOW DEUTERON ENERGIES. Richard H. Stokes (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 121: 613-18 (Jan. 15, 1961).

Deuterons of 9.1, 8.3, and 7.4 Mev were used to produce (d,p) reactions in Pb^{208} and Bi^{209} targets. The proton differential cross section was measured for different Q values, each of which corresponded to a final state of known assignment. With one exception, all the observed angular distributions were broad peaks with maxima near 180°. The theoretical approximations that apply for low deuteron energy predict a Gaussian distribution peaked in the backward direction. Although the measured distributions were not of Gaussian form, a comparison of the measured and predicted width variation with Q showed fair agreement with one theoretical result and poor agreement with the other. For the reaction with the highest Q(≈4.5 Mev), a peak near 120° was observed. This more forward peak would be expected both from a reduced Coulomb effect and from the influence of the nuclear potential on the proton. As expected when the Coulomb field is dominant, there was only a small observed correlation between the measured angular distribution and the angular momentum of the captured neutron. In a few cases, triton angular distributions from (d,t) reactions were measured, and these also showed peaks at large scattering angles. (auth)

10076 INELASTIC SCATTERING OF ELECTRONS FROM He^4. George R. Burleson (Stanford Univ., Calif.). Phys. Rev., 121: 624-30(Jan. 15, 1961).

The inelastic scattering of electrons from He^4 which corresponds to a disintegration of the nucleus was studied for incident electron energies of 400 and 500 Mev at laboratory angles from 45 to 135°. The energy spectra of the scattered electrons were measured, and absolute cross sections were found by comparison with elastic scattering from hydrogen. The curves were corrected for electron radiation. Within the validity of adapting to He^4 one of the results of the Goldberg theory of deuteron electrodisintegration, the cross sections at the maxima of the curves gave a value for $M(1/p)_\alpha$ of (7.5 ± 1.5), where M is a nucleon mass and $(1/p)_\alpha$ is the expectation value of the reciprocal of the momentum of a nucleon bound in He^4. With a single exception, the energy-integrated cross sections $d\sigma_\alpha/d\Omega$ agreed within experimental error with $d\sigma_\alpha/d\Omega = 2(d\sigma_p/d\Omega + d\sigma_n/d\Omega)$, where $d\sigma_p/d\Omega$ is the free-proton cross section and $d\sigma_n/d\Omega$ is the neutron cross section found from inelastic scattering from deuterium. (auth)

10077 SYMMETRY THEOREMS FOR ISOSPIN-INVARIANT REACTIONS. Murray Peshkin (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 121: 636-42(Jan. 15, 1961).

Symmetry theorems, analogous to those well known for angular distributions and correlations, are given for isospin-invariant reactions starting from an initial state of limited complexity. Detailed calculations were carried out when the initial-state isospin did not exceed $^{3}/_{2}$. A statisti-

cal generalization is given for averages over experiments starting from different charge states. Some properties of the irreducible tensor operators which arise from recoupling the angular momentum operator to itself are discussed. (auth)

10078 EXCHANGE INTEGRAL IN COBALT FROM SPIN-WAVE RESONANCE. P. E. Tannenwald and R. Weber (Massachusetts Inst. of Tech., Lexington). Phys. Rev., 121: 715(Feb. 1, 1961).

The exchange constant A and exchange integral J, and their temperature dependences, were measured in cobalt metal films by spin-wave resonance. At room temperature, $A = 1.30 \times 10^{-6}$ erg/cm and J = 155k. J is temperature independent between 4 and 295°K. Comparison was made with recent data obtained by other experimental methods. (auth)

10079 KNIGHT SHIFT IN POTASSIUM. F. J. Milford and W. B. Gager (Battelle Memorial Inst., Columbus, Ohio). Phys. Rev., 121: 716-20(Feb. 1, 1961).

The K^{39} nuclear magnetic resonance was observed in metallic potassium and in aqueous solutions of KNO_3 and $K_3Co(CN)_6$. From these observations a Knight shift of $(0.248 \pm 0.005)\%$ was obtained. Using Pines' value 0.60×10^{-6} for the spin susceptibility gave $P_f = 0.95\ a_0^{-3}$. This was compared with the theoretical values $0.786\ a_0^{-3}$ obtained by Callaway and $0.909\ a_0^{-3}$ obtained by a quantum defect calculation. (auth)

10080 APPLICATION OF THE METHOD OF POLARIZED ORBITALS TO THE SCATTERING OF ELECTRONS FROM HYDROGEN. A. Temkin and J. C. Lamkin (National Bureau of Standards, Washington, D. C.). Phys. Rev., 121: 788-94(Feb. 1, 1961).

The s-, p-, and d-wave scattering of slow electrons from atomic hydrogen was calculated by the method of polarized orbitals. Utilization of a transformation of Omidvar avoided the iterative procedure of solving the associated integro-differential equations. The s-wave scattering was smaller than that given by the exchange approximation, and the scattering lengths were within the upper bounds found by Rosenberg, Spruch, and O'Malley. The d-wave phase shifts were too small to explain a resonance in the total cross section. However, they were much larger than those of the exchange or Born approximation, and they gave considerable structure to the differential cross-section curves. The p-wave phase shifts were not much increased by the polarization effects. (auth)

10081 COLLISIONS OF ELECTRONS WITH HYDROGEN ATOMS. VI. ANGULAR DISTRIBUTION IN ELASTIC SCATTERING. H. B. Gilbody, R. F. Stebbings, and Wade L. Fite (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Rev., 121: 794-8(Feb. 1, 1961).

The angular distribution of electrons scattered elastically by hydrogen atoms was determined for electron energies below 10 ev. The elastically scattered electrons arising from the interaction of crossed electron and modulated hydrogen-atom beams were examined over an angular range extending from 30 to 120°. The results are discussed with reference to other recent experimental and theoretical developments. (auth)

10082 NUCLEAR MAGNETIC INTERACTIONS IN HYDROGEN FLUORIDE. Milton R. Baker, H. Mark Nelson, John A. Leavitt, and Norman F. Ramsey (Harvard Univ., Cambridge, Mass.). Phys. Rev., 121: 807-15(Feb. 1, 1961).

The radio-frequency spectra corresponding to the reorientation of the proton and fluorine nuclear magnetic moments in hydrogen fluoride (HF) were observed in fields of 900, 1800, and 3600 gauss by means of the molecular beam resonance method. Details are presented on the design and construction of the new molecular beam apparatus and electron-bombardment detector used in the experiment. The theory of the HF strong-field energy levels is outlined, and the expected proton and fluorine transitions derived for J = 0, 1, and 2 are tabulated. From the observed resonance shapes, the magnitudes of the spin-rotational interactions of the proton and fluorine nuclei and their spin-spin interaction were deduced. These are: $|c_p| = 71 \pm 3$ kc/sec, $|c_F| = 305 \pm 2$ kc/sec, and $d_1 = 57 \pm 2$ kc/sec. The correctness of these parameters was checked by the good agreement between the experimental curves and resonance shapes predicted by Univac programs using these values. The observed fluorine spin-rotational interaction constant is the largest yet observed and corresponds to a rotational magnetic field at the nucleus of 76 gauss per unit rotational quantum number. The implications of the large spin-rotational interaction for relaxation processes in nuclear magnetic resonance experiments are discussed. (auth)

10083 DEUTERON STRIPPING AND PICKUP REACTIONS IN OXYGEN-16. Eldon L. Keller (Univ. of Pittsburgh). Phys. Rev., 121: 820-4(Feb. 1, 1961).

The reactions $O^{16}(d,p)O^{17}$ and $O^{16}(d,t)O^{15}$ were studied by bombarding thin nickel oxide foils with 15-Mev deuterons from the University of Pittsburgh cyclotron. The reaction particles were magnetically analyzed and detected either by nuclear emulsions or by a CsI(Tl) scintillator. Angular distributions and absolute cross sections were obtained for the first six states of O^{17} and for the ground state of O^{15}. Reduced widths having values $\Theta^2 = 0.045$, 0.16, 0.0024, 0.0024, 0.0071, 0.047, and 0.012, respectively, were extracted from a comparison of the data with the predictions of Butler stripping theory. The results of the (d,p) experiment indicated that: the $\frac{7}{2}^-$ state at 3.846 Mev does not appear to be a good $1f_{\frac{7}{2}}$ single-particle state, the $2p_{\frac{3}{2}}$ single-particle component seems to be fragmented over more than two states, and the $\frac{1}{2}^-$ state at 3.058 Mev contains a $2p_{\frac{1}{2}}$ single-particle component. The results of the (d,t) experiment suggested a dependence of the 1p single-particle reduced width on Q value. (auth)

10084 LITHIUM-INDUCED REACTION YIELDS BELOW 4 Mev. Edwin Norbeck (Univ. of Minnesota, Minneapolis). Phys. Rev., 121: 824-7(Feb. 1, 1961).

Thick-target yields of the following reactions were measured by counting the β active products: $Li^7(Li^6,2n)C^{11}$, $Be^9(Li^6,2n)N^{13}$, $C^{12}(Li^6,n)F^{17}$, $C^{12}(Li^7,n)F^{18}$, $N^{14}(Li^6,He^5)O^{15}$, $N^{14}(Li^6,d)F^{18}$, $N^{14}(Li^7,t)F^{18}$, $O^{16}(Li^6,n)Na^{21}$, $O^{16}(Li^6,He^4)F^{18}$, $F^{19}(Li^6,Li^5)F^{20}$, and $Na^{23}(Li^6,Li^5)Na^{24}$. The reactions $F^{19}(Li^6,2p)Ne^{23}$ and $Na^{23}(Li^7,Li^6)Na^{24}$ had too small a yield to permit accurate measurement. All of the yield curves showed a very rapid but smooth increase of yield with energy. Some general rules are given for estimating the yield to be expected for any positive "Q" lithium beam reaction in the energy range under consideration. (auth)

10085 $Al^{27}(n,\alpha)Na^{24}$ CROSS SECTION AS A FUNCTION OF NEUTRON ENERGY. H. W. Schmitt and J. Halperin (Oak Ridge National Lab., Tenn.). Phys. Rev., 121: 827-30(Feb. 1, 1961).

The cross section for the $Al^{27}(n,\alpha)Na^{24}$ reaction was measured as a function of neutron energy in the range $6.1 \leq E_n \leq 8.3$ and 14.8 Mev. Measurements were made relative to the fission cross section of U^{238}; activation techniques were used to determine the number of $Al^{27}(n,\alpha)$ events. While a number of peaks and valleys appear in the cross section versus energy curve, there is a general in-

crease in cross section with increasing energy consistent with the Coulomb penetrability of the α particle. (auth)

10086 DECAY OF $_{68}Er^{161}$ (3.1 Hr). H. A. Grench and S. B. Burson (Argonne National Lab., Ill.). Phys. Rev., 121: 831-40(Feb. 1, 1961).

Sources of $_{68}Er^{161}$(3.1 hr) were produced by the (n,2n) and (γ,n) reactions. A study of the γ spectrum by means of scintillation coincidence spectrometry indicated 32 γ rays. All but three of these were fitted into a tentative decay scheme with levels at 0, 211, 585, 826, 945, 1165, 1253, 1315, 1395, 1450, (1604), 1700, and 1830 kev. The data are consistent with a $\frac{3}{2}^-$ spin assignment to the erbium ground state and $\frac{7}{2}^-$ and $\frac{1}{2}^+$ assignments to the ground state and 211-kev state of holmium, respectively. The 826-kev level in holmium probably has $\frac{5}{2}^-$ character. (auth)

10087 COMPARISON OF INELASTIC SCATTERING FROM Sm^{152} WITH COULOMB EXCITATION THEORY. E. M. Bernstein and E. Z. Skurnik (Universitet, Copenhagen). Phys. Rev., 121: 841-5(Feb. 1, 1961).

In order to check the theory of electric quadrupole Coulomb excitation, accurate measurements were made of differential cross sections for inelastic scattering from the first excited state of Sm^{152}. Protons, deuterons, and α particles of energies in the region of 4 Mev were used as the bombarding particles. In addition to the angular distribution of inelastically scattered deuterons, measurements were also made with protons at two scattering angles and at a backward angle with deuterons and α particles of different incident energies. The data are found to be in excellent agreement with the semiclassical description of the Coulomb excitation process. (auth)

10088 HALF-LIFE OF O^{14}. D. L. Hendrie and J. B. Gerhart (Univ. of Washington, Seattle). Phys. Rev., 121: 846-9(Feb. 1, 1961).

The half life of O^{14} was remeasured and found to be (70.91 ± 0.04) seconds. The corresponding partial half life for the $0^+ \rightarrow 0^+$ β transition was found to be (71.34 ± 0.08) seconds. These results are about 1.6% less than reported earlier. The new half life was combined with the O^{14} endpoint energy as recently determined by Bardin et al., to reevaluate the Fermi coupling constant for β decay. From this, the mean life of the μ meson was calculated. The predicted mean life was greater than the observed value by (3.3 ± 0.4)% if the radiative corrections of Kinoshita and Sirlin were used, and by (1.4 ± 0.4)% if the radiative corrections of Durand et al., were used. (auth)

10089 ANGULAR DISTRIBUTIONS FOR $C^{13}(d,n)N^{14}$. Richard Zdanis, George E. Owen, and L. Madansky (Johns Hopkins Univ., Baltimore). Phys. Rev., 121: 854-7 (Feb. 1, 1961).

Angular distributions of neutrons corresponding to transitions to the first (2.31 Mev) and second (3.95 Mev) excited states in the reaction $C^{13}(d,n)N^{14}$ were measured at an incident deuteron energy of 1.3 Mev. A time-of-flight technique utilizing the associated γ ray as a trigger was employed to separate the various neutron groups. Because the data, particularly for the first excited state transition, exhibited a relatively large intensity in the backward direction, a simple deuteron-stripping process is not sufficient to account for the results. An analysis that included the heavy-particle stripping mode was consistent with the data. (auth)

10090 INVERSE PHOTONUCLEAR REACTIONS $N^{14}(p,\gamma)O^{15}$ AND $N^{15}(p,\gamma)O^{16}$ IN THE REGION OF THE GIANT RESONANCE. S. G. Cohen, P. S. Fisher, and E. K. Warburton (Princeton Univ., N. J.). Phys. Rev., 121: 858-65 (Feb. 1, 1961). (PUC-1960-16)

The 90° yield of γ rays to the O^{15} ground state from the $N^{14}(p,\gamma)O^{15}$ reaction was measured for proton energies between 12 and 19.5 Mev, covering the region of excitation in O^{15} between 18 and 25 Mev. The excitation curve was quite flat (with $d\sigma/d\Omega$ at 90° ≈ 16 μb/4π sr), and showed little evidence of the giant resonance. The results for O^{15} were compared to those for N^{15} obtained by Jacobs and Stephens by means of the $N^{15}(\gamma,p)C^{14}$ reaction. The 90° yield of γ rays to the O^{16} ground state from the $N^{15}(p,\gamma)O^{16}$ reaction was measured for proton energies between 10 and 15 Mev, corresponding to O^{16} excitation energies between 21 and 26 Mev. The excitation curve showed two large resonances peaked at 21.8 and 24.7 Mev with integral total cross sections of about 0.27 Mev-mb each if no background was assumed. The O^{16} results were compared with theoretical calculations of Elliott and Flowers, and of others. (auth)

10091 RADIATIONS FROM HIGH-ENERGY POSITRONS INCIDENT ON A BERYLLIUM TARGET. C. P. Jupiter, N. E. Hansen, R. E. Shafer, and S. C. Fultz (Univ. of California, Livermore). Phys. Rev., 121: 866-70(Feb. 1, 1961). (UCRL-6044)

The energy spread and yields of nearly monoenergetic photons of various energies produced by the annihilation in flight of relativistic positrons were experimentally determined using a 6-in.-long by 5-in.-diameter NaI(Tl) crystal spectrometer. Photon lines with an energy spread of a few per cent are reported. Yields of positrons and monoenergetic photons in the energy range from 2 to 14 Mev were measured. The bremsstrahlung spectra from 8.5-Mev positrons and electrons were compared and the yields and spectral distributions were found to agree within the experimental error. (auth)

10092 RELATIVE YIELDS OF NEUTRON GROUPS FROM THE $Li^7(p,n)Be^7$, Be^{7*} REACTIONS. P. R. Bevington, W. W. Rolland, and H. W. Lewis (Duke Univ., Durham, N. C.). Phys. Rev., 121: 871-6(Feb. 1, 1961).

The relative yields of the two groups of neutrons from the $Li^7(p,n)Be^7$, Be^{7*} reaction, leading to the ground state and the 430-kev state of Be^7, were measured with a time-of-flight system, using pre-acceleration pulsing of the accelerator beam. Data were taken at 30° intervals between 0 and 150° for proton energies high enough to produce (p,n') neutrons above the detection threshold (300 kev). Since the yield of the (p,n) reaction is more highly peaked in the forward direction than that of the (p,n') reaction, the ratio of the (p,n') to (p,n) intensities grows with increasing angle, severely limiting the usefulness of the (p,n) reaction as a neutron source above the (p,n') threshold at back angles. Absolute differential and total cross sections for both groups were calculated from the data. A comparison with theory for total cross sections and angular distributions suggested the existence of three previously unidentified levels in Be^8. One level, with $J^\pi = 1^-$, near the threshold for the (p,n') reaction, is responsible for the fast rise in the (p,n') total cross section near threshold. A second level, corresponding to an incident proton energy of about 3.0 Mev, does not contribute significantly to the yield of the (p,n') reaction; the data are consistent with an assignment of $J^\pi = 1^+$ and a total width of 1 Mev. The bulk of the total cross-section curve for the (p,n') reaction was fitted by assuming a 1^+ level corresponding to an incident proton energy of 3.5 Mev, with $\gamma_n^2 \simeq \gamma_p^2$, $\gamma_{n'}^2 \simeq 5\gamma_{p'}^2$, and $\gamma_{p'}^2 \ll \gamma_p^2$. (auth)

10093 PROTON GROUPS FROM THE $Fe^{19}(\alpha,p)Ne^{22}$ REACTION AND THE $Ca^{40}(\alpha,p)Sc^{43}$ REACTION. H. J.

Martin, M. B. Sampson, and D. W. Miller (Indiana Univ., Bloomington). Phys. Rev., 121: 877-9(Feb. 1, 1961).

A CaF_2 target was bombarded with 21.9-Mev α particles, and the energies of the outgoing protons were measured with a magnetic spectrometer. Proton groups leading to energy levels in Ne^{22} at excitation energies of 0, 1.28, 3.37, 4.52, 5.18, 5.67, 6.41, 6.88, and 7.49 Mev were seen. The ground state Q value for the $Ca^{40}(\alpha,p)Sc^{43}$ reaction was found to be -3.47 ± 0.030 Mev. Some information about absolute cross sections and angular distributions for the fluorine and calcium reactions is also presented. (auth)

10094 PHOTONUCLEAR STUDIES WITH MONOENERGETIC GAMMA RAYS FROM THERMAL NEUTRON CAPTURE. Robert E. Welsh and D. J. Donahue (Pennsylvania State Univ., University Park). Phys. Rev., 121: 880-5(Feb. 1, 1961).

Monoenergetic γ rays produced when neutrons are captured in various materials were used to study the following reactions: $Ta^{181}(\gamma,n)Ta^{180m}$ (8.15 hr), $Au^{197}(\gamma,n)Au^{196}$ (5.6 days), $Ho^{165}(\gamma,n)Ho^{164}$ (34 min), $Ag^{107}(\gamma,n)Ag^{106}$ (24 min), and $Nb^{93}(\gamma,n)Nb^{92}$ (10 days). Cross sections for these reactions were obtained at several discrete energies between 7.5 and 10.8 Mev. Estimates were also made of the thresholds of these reactions. Two of the thresholds so obtained, $Ta^{181}(\gamma,n)Ta^{180m}$, $E_t = 7.60 \pm 0.08$ and $Nb^{93}(\gamma,n)Nb^{92}$, $E_t = 8.99 \pm 0.04$, have precisions comparable with those of previous measurements of the same quantities. (auth)

10095 DETERMINATION OF THE PARITY CHANGE IN INELASTIC SCATTERING FROM THE ANGULAR DISTRIBUTION. A. J. Kromminga and I. E. McCarthy (Univ. of Adelaide). Phys. Rev. Letters, 6: 62-3(Jan. 15, 1961).

Comparison of angular distributions in the approximate range from 20 to 90° was investigated in order to determine the parity change of the nuclear state. Glendenning's theoretical examples of angular distribution in which the forward differential cross section was very small for odd-parity change and very large for even-parity change were studied. It is shown in the distorted-wave Born approximation that, for reasonably small momentum transfers, Glendenning's theoretical predictions are true. (M.C.G.)

10096 DECAY SCHEME OF Eu^{156}. Kumari S. Y. Ambiye, S. D. Bhagwat, M. C. Joshi, R. P. Sharma, and B. N. Subbarao (Tata Inst. of Fundamental Research, Bombay, India). Proc. Indian Acad. Sci., Sec. A, 52: 157-63 (1960).

Decay of 15-day activity of Eu^{156} was studied using an intermediate image β-ray spectrometer and β-γ, β-e and γ-γ coincidence techniques. The β-groups, $\beta_1 = 2450$ kev, $\beta_2 = 1180$ kev, $\beta_3 = 720$ kev, and $\beta_4 = 480$ kev, and the γ-rays (kev) at 89, 201, 630, 710, 810, 930, 1050, 1140, 1250, 1460, 2050, and 2180 were identified. From coincidence studies, energy levels in Gd^{156} are proposed at (kev) 89, 290, 1140, 1360, 1540, 1840, 2050, and 2180. (auth)

10097 CALCULATION OF THE ANGULAR DISTRIBUTION OF $Li^6(n;n',\gamma)Li^6$ BY INTERMEDIATE-COUPLING SHELL MODEL. Cecilia Mossin Kotin (Univ. Buenos Aires, Argentina). Rev. mex. fís., 9: 73-83(1960). (In Spanish)

The intermediate-coupling shell model is used to calculate the angular distribution of the inelastic scattering $Li^6(n,n')Li^6$ and the angular correlation $Li^6(n;n',\gamma)Li^6$, both involving the 7.46-Mev compound state of Li^7. The intermediate-coupling parameter $\zeta = 1.08$ was used, which is in good agreement with the energy levels of Li^7. It is the only parameter that enters in this reaction. (auth)

10098 THE γ RAYS OF LOW ENERGY EMITTED DURING THE CAPTURE OF THERMAL NEUTRONS IN As^{75}. V. Cojocaru, M. Cristu, D. Dorcioman, and D. Dragomirescu. Rev. phys., Acad. rép. populaire Roumaine, 5: 211-16 (1960). (In French)

The low-energy γ rays emitted during thermal neutron capture by As^{75} were studied. The apparatus used and the geometric arrangement are described in some detail. Gamma rays were observed at 450, 403, 311, 249, 205, and 172 kev. The increase in the counting rate observed at 500 and 600 kev was probably caused by the 558-kev ray of Se^{76} and by the 511-kev annihilation ray. The possible transitions and the relative intensities of the rays observed are tabulated. (J.S.R.)

10099 INVESTIGATIONS ON SELF-TARGETS FOR THE $D(d,n)He^3$ REACTION. Roland Weisbeck (Univ., Cologne, Germany). Z. angew. Phys., 12: 529-38(Dec. 1960). (In German)

An apparatus with which systematic investigations on self-targets for the $D(d,n)He^3$ reactions at 128-kev deuteron energy and 80 μamp deuteron current were made is reported. Massive, galvanized, and flame-sprayed samples of 31 elements, 8 alloys, and 1 compound were studied. The neutron saturation yield (A_∞) depends strongly on the target material and its surface condition. Variations in the yield by a factor of 210 were measured. The initial tangent $(\partial A/\partial t)_{t=0}$ of the yield curve is also strongly material-dependent. Variations by a factor of 40 occur. In general, the initial tangent within one group of the periodic system increases with the atomic number. An empirical relationship exists between $(\partial A/\partial t)_{t=0}$, A_∞, and $t_{1/2}$ (time to reach $A_{\infty/2}$). For alloys A_∞ is smaller than the largest A_∞ value of the alloy constituents. Although massive and galvanized layers of the same material show the same behavior, flame-sprayed layers behave differently. The pattern of the yield curve was explained on the basis of the hypothesis, suggested by experiments, that projected deuterons essentially diffuse only in the penetrated layer, and by means of the diffusion theory and an assumption on the dependence of the cross section of the D,D reaction on the depth $\underline{x}$. Two cases were studied. In the first at the position $\underline{x} = R$ (where R signifies a material-dependent range uniform for all monoenergetic deuterons) a surface source for deuterium is found. In the second case, the deuterium source is expanded in the form of a Gaussian distribution around a mean range R. It is shown that four material-dependent magnitudes determine the behavior of the yield curve: the diffusion coefficient D, the range R, the slope γ of the range-energy curve, and the value α, a measurement for the half-value width of the Gaussian distribution. (tr-auth)

10100 CONVERSION LINE SPECTRUM OF Po^{214} (RaC'). G. Lührs and C. Mayer-Böricke (Max-Planck Inst. für Kernphysik, Heidelberg, Germany). Z. Naturforsch., 15a, 939-49 (Nov. 1960). (In German)

The conversion line spectrum of Po^{214} was measured with a double focusing β spectrometer in the region 2600 to 13,500 gauss · cm (Rn^{222} source). The energy and absolute intensity of about 60 conversion lines (among these a number of hitherto unknown lines) was determined. In about 20 cases the absolute conversion coefficients of γ transitions were determined and compared with the tables of Sliv and Band and/or Rose to find out multipolarities. In some cases the K/L-ratios could also be measured, and the results agree well with the conclusions drawn from the interpretation of the absolute conversion coefficients. A tentative decay scheme for the decay $Bi^{214}-Po^{214}$ was estab-

lished using the information about conversion lines and all other known data concerning this decay. The endpoint energy of the RaC β spectrum was found to be (3275 ± 15) kev. (auth)

10101 THE THEORY OF NUCLEAR FISSION. W. Brunner and H. Paul (Deutsche Akademie des Wissenschaften, Berlin, Germany). Z. Naturforsch. 15a, 1018-19 (Nov. 1960). (In German)

In the theory of nuclear reactions, it is usual to neglect the number of interactions by nuclear forces for distances greater than the channel radius. Because of the unsatisfactory character of the usual theory of nuclear fission, it appeared profitable to investigate the effect of the nuclear forces, which are still effective between fission fragments even after their separation, on nuclear fission. The fission of U^{235} by thermal neutrons was considered. Expressions for the depth of the nuclear force potential were derived and expressed as a function of the mass ratio. Deformation dependence on neutron number was determined. It is shown that the structure dependence of nuclear force interaction can be explained by the structure dependence of the deformation of the fission fragments. (J.S.R.)

10102 POLARIZATION OF 6.8 Mev PROTONS SCATTERED ON CARBON. M. V. Pasechnik, N. N. Pucherov, B. F. Orlenko, and V. S. Prokopenko (Inst. of Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret Fiz., 39: 915-16(Oct. 1960). (In Russian)

Experiments on double scattering of 6.8-Mev protons were performed. The large value of the polarization of protons scattered on carbon indicates the importance of spin-orbit interaction during scattering. An angular dependence of the polarization is noted. (auth)

10103 ANGULAR DISTRIBUTION OF α-PARTICLES PRODUCED IN THE REACTION $F^{19}(p,\alpha)O^{16}$. I. B. Teplov, O. P. Shevchenko, and E. K. Ruuge (Inst. of Nuclear Physics, Moscow State Univ., U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 923-8(Oct. 1960). (In Russian)

A telescope consisting of three proportional counters was employed to measure the angular distributions of α particles from the $F^{19}(p,\alpha)O^{16}$ reaction in which the O^{16} nucleus is produced in the ground state. The measurements were carried for angles in the range from 20 to 160° and for 11 values of the bombarding proton energies lying between 5.1 and 6.5 Mev. All the experimental angular distributions were found to be very anisotropic. The results obtained are discussed from the viewpoint of the reaction mechanism. (auth)

10104 ANGULAR AND MOMENTUM DISTRIBUTION OF RESIDUAL NUCLEI PRODUCED IN THE INELASTIC SCATTERING OF FAST π-MESONS AND PROTONS ON HELIUM. M. S. Kozodaev, M. M. Kulyukin, R. M. Sulyaev, A. I. Filippov, and Yu. A. Shcherbakov (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 929-36(Oct. 1960). (In Russian)

The angular and momentum distributions of residual nuclei produced as a result of quasi-free interaction of fast π mesons or protons with the nucleons of helium nuclei were investigated. It was found that the shape of the distributions can be explained within the framework of the Serber-Goldberger model if transfer of the additional momentum due to coupling is taken into account. The possibility of obtaining information on the momentum distribution of nucleons in the helium nucleus from the momentum spectrum of the residual nuclei is discussed. The momentum distribution of the nucleons can be satisfactorily described by a Gaussian function which decreases to the 1/e value at an energy $E_0 = (12 \pm 2)$ Mev. (auth)

10105 INELASTIC INTERACTIONS BETWEEN 7 BeV π^--MESONS AND NUCLEONS. V. A. Belyakov, Wang Shu-fen, V. V. Glagolev, N. Dalkhazhav, R. M. Lebedev, N. N. Mel'nikova, V. A. Nikitin, V. Petrzhilka, V. A. Sviridov, M. Suk, and K. D. Tolstov (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 937-47(Oct. 1960). (In Russian)

535 π^- N-interactions in photographic emulsion were analyzed for ~7 Bev mesons. A large asymmetry was observed in the c.m.s., the nucleons predominantly being emitted toward the back hemisphere. Moreover the transverse and longitudinal momenta of the emitted nucleons were found to be independent of the number of secondary charged particles. The fast π mesons were characterized by a considerable anisotropy in the angular distribution whereas slow mesons were emitted isotropically (in the πN c.m.s.). The mean momentum of the fast π mesons was equal to that of the protons. The total number of produced π mesons did not strongly depend on the number of concurrently produced charged particles. The multiplicity distribution and the mean multiplicity could be made consistent with statistical theory calculations but the angular and momentum distributions (especially for nucleons) contradicted the theory. An attempt was made to estimate the upper limit of the radius of the nuclear core. (auth)

10106 QUADRUPOLE MOMENTS OF ODD BARIUM ISOTOPES. N. I. Kaliteevskiĭ, E. E. Fradkin, and M. P. Chaĭka (Leningrad State Univ., U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 954-6(Oct. 1960). (In Russian)

The quadrupole moments of the Ba^{135} and Ba^{137} nuclei were determined on the basis of the deviations from spacing rule of the hyperfine structure of the Ba^{137} spectrum. The absolute magnitude of the moments cannot be interpreted in terms of the simple shell model. (auth)

10107 INELASTIC INTERACTIONS BETWEEN 9 BeV PROTONS AND NUCLEONS. Wang Shu-Fen, T. Vishki, I. M. Gramenitskiĭ, V. G. Grishin, N. Dalkhazhov, R. M. Lebedev, A. A. Nomofilov, M. I. Podgoretskiĭ, and V. N. Strel'tsov (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 957-60(Oct. 1960). (In Russian)

It is shown that in p-p and p-n interactions the angular and momentum distributions of secondary protons and π mesons weakly change with variation of the number of charged particles. (auth)

10108 ON THE PRODUCTION OF MONO-ENERGETIC POSITRONS IN THE DECAY OF Eu^{152}. S. S. Vasilenko, M. G. Kaganskiĭ, D. L. Kaminskiĭ, and S. F. Koksharova (Leningrad Inst. of Physics and Tech., U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 970-2(Oct. 1960). (In Russian)

The production of mono-energetic positrons may occur in the de-excitation of the 1531-kev excited state of Sm^{152} which is formed in the decay of Eu^{152}. Our measurements show that the probability for this process is less than 10^{-8} positron per decay. In accordance with the calculations of L. A. Sliv this yields for the 1531-kev excited state of Sm^{152} a lifetime exceeding 10^{-14} sec which points to the collective character of this level. (auth)

10109 FIVE NEW MILLISECOND ISOMERS PRODUCED IN NUCLEAR REACTIONS INVOLVING 19.2 MeV PROTONS. A. M. Morozov, V. V. Remaev, and P. A. Yampolskiĭ (Inst. of Chemical Physics, Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 973-85 (Oct. 1960). (In Russian)

Five new short-lived isomers produced by irradiating Sc_2O_3, Nb, La_2O_3, Nd_2O_3, and Os specimens with 19.2-Mev protons were detected and investigated. The final products

of the nuclear reactions yielding isomers from scandium and lanthanum were identified as Ti^{45m} and Ce^{138m}, respectively. For the first time the previously known isomer In^{114m} was found to appear in proton reactions on indium. More detailed information was obtained on the characteristics of the In^{114m} isomer previously detected in irradiated cadmium samples. The excitation function and cross section of the reaction at an energy of 19.2 Mev were determined for this isomer. The γ ray energy, half lives, and relative yields from thick targets were determined for all of the short-lived isomers. (auth)

10110 PRODUCTION OF THE RADIOACTIVE ISOTOPE Kr^{85} AND MEASUREMENT OF ITS γ-RADIATION. I. E. Nakhutin, V. V. Ovechkin, D. V. Ochkin, A. S. Polyakov, and Z. K. Khodulyeva. Zhur. Eksptl'. i Teoret Fiz., 39: 991-2 (Oct. 1960). (In Russian)

The radioactive isotope Kr^{85} was obtained from neutron-irradiated uranium by frontal chromatography of the gases evolved during solution of the uranium in nitric acid. The Kr^{85} thus obtained was used to determine the γ radiation yield. The γ ray quantum yield was $(0.41 \pm 0.06)\%$ per decay which is much smaller than the value given by Zeldes et al. (auth)

10111 INTERACTION OF $5 \cdot 10^{12}$ eV NUCLEONS WITH PHOTOGRAPHIC EMULSION NUCLEI. N. A. Marutyan, K. A. Matevosyan, and R. T. Toshyan (Inst. of Physics, the Academy of Sciences, Armenian, S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 993-6(Oct. 1960). (In Russian)

An estimation is made of the energy of shower particles produced in 6 + 31 p type interactions, the primary particle energy being $\sim 5 \times 10^{12}$ ev. The mean transverse momentum was (0.17 ± 0.02) Bev/c. The fraction of the primary particle energy involved in the formation of secondary particles was >10%. The angular distribution and the transverse momentum distribution obtained were compared with Landau's hydrodynamic theory. The best agreement for the transverse momentum distribution was obtained for $kT = \frac{1}{2}\mu_\pi c^2$. The mean nuclear interaction path was of the order of 30 cm. (auth)

10112 FAST PHOTONEUTRONS FROM SOME ELEMENTS. L. A. Kul'chitskiĭ and V. Presperin (Leningrad Inst. of Physics and Technology, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1001-4(Oct. 1960). (In Russian)

The angular distributions of photoneutrons possessing energies $\gtrsim$10 Mev produced by irradiating lithium and iodine with 90 Mev peak energy bremsstrahlung were investigated. The distribution was found to be highly asymmetric with respect to the angle 90°, most of the neutrons being emitted at small angles. The energy distributions of neutrons and protons measured with the same apparatus were compared. The yields of fast photoneutrons from some elements were measured. (auth)

10113 POLARIZATION OF DEUTERONS ELASTICALLY SCATTERED ON HELIUM. L. S. Dul'kova. Zhur. Eksptl'. i Teoret Fiz., 39: 1008-10(Oct. 1960). (In Russian)

Results of a numerical calculation of the polarization tensor components of deuterons elastically scattered on helium are presented. The calculations were performed for angles of 40, 50, 60, 70, and 90° in the c.m.s. and an energy range 1 to 3 Mev and were based on a phase shift analysis of available experimental data. (auth)

10114 ON THE INFLUENCE OF THE INELASTIC PROCESSES ON THE ELASTIC SCATTERING IN THE VICINITY OF THE THRESHOLDS OF THE INELASTIC REACTION MODES. L. A. Khalfin. Zhur. Eksptl'. i Teoret Fiz., 39: 1020-2(Oct. 1960). (In Russian)

It is shown that the specific effects in the vicinity of the thresholds of the inelastic reactions can be considered in the general case on the basis of the dispersion relations. (auth)

10115 EFFECT OF EXTERNAL FIELDS ON THE ANGULAR CORRELATIONS AND RESONANCE PROCESSES DURING QUANTUM TRANSITIONS. L. G. Zastavenko and M. I. Podgoretskiĭ (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1023-6(Oct. 1960). (In Russian)

Scattering of light and γ rays on isolated and overlapping magnetic sublevels is considered. A new method for experimental determination of the Stark constant and the gyromagnetic ratios is discussed. (auth)

10116 THEORY OF PHOTONUCLEAR REACTION ON LIGHT NUCLEI INVOLVING THE EMISSION OF DEUTERONS. G. M. Shklyarevskiĭ (Leningrad Inst. of Physics and Technology, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1031-8(Oct. 1960). (In Russian)

A theory of the γ-d reaction on light nuclei was developed within the framework of the independent pair model in the small correlator approximation. The mechanism of excitation of the product nucleus as a result of rapid variation of the self-consistent field of the nucleus during emission of a pair of nucleons was considered and the excitation probability in the region of the continuous spectrum was calculated for the case of independent particles. Correct values for the γ-d cross sections on light nuclei and also the shapes of the energy spectra and angular distributions can be obtained by employing values of the parameters involved in the theory which are presented in the literature. (auth)

10117 ELASTIC RESONANCE SCATTERING OF SLOW NEUTRONS IN CRYSTALS. M. V. Kazarnovskiĭ and A. V. Stepanov (Lebedev Inst. of Physics, the Academy of Sciences, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1039-41 (Oct. 1960). (In Russian)

Formulas for the differential cross section for elastic resonance scattering of slow neutrons in crystals were derived. The expressions obtained are evaluated in the Debye approximation. (auth)

10118 ROTATIONAL STATE ENERGIES OF NONAXIAL NUCLEI WITH J = 10 AND J = 12. V. K. Luk'yanov (Saratov State Univ., U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1051-2(Oct. 1960). (In Russian)

Energy levels of the lower rotational band in nonaxial nuclei were derived for J = 10 and J = 12. A comparison is made with the experimental data for U^{238} and Th^{232}. (auth)

10119 ELASTIC SCATTERING OF γ-QUANTA BY NUCLEI. L. I. Lapidus, Chou Kuang-chao (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1056-8(Oct. 1960). (In Russian)

The energy dependence of the cross section for elastic scattering of γ quanta near the photonuclear threshold was studied with the help of the dispersion relation for forward scattering. The first peak in the scattering cross section was attributed to dispersion effects. Experiments required for a more detailed analysis are discussed. (auth)

10120 A METHOD OF CALCULATION OF THE STATISTICAL WEIGHTS AND DISTRIBUTIONS IN MULTIPLE PRODUCTION THEORIES. G. I. Kopylov (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1091-8(Oct. 1960). (In Russian)

An effective method was developed for obtaining the distributions and correlations in arbitrary models of multiple production. The formulas for the covariant model are especially simple. It is shown that a study of this model may

facilitate the calculations for more complicated models. (auth)

10121 ON THE POSSIBILITY OF PROTON DECAY OF NUCLEI. V. A. Karnaukhov and N. I. Tarantin. Zhur. Eksptl'. i Teoret Fiz., 39: 1106-11(Oct. 1960). (In Russian)

The possible existence of proton radioactivity is considered. The nuclear region in which it seems most feasible to seek proton radioactive isotopes was determined. The expected lifetimes of p-active nuclei were estimated. The role of competing processes (α, β^+ decay, K capture) is discussed. Possible reactions leading to the formation of p-active isotopes are indicated and their cross sections were estimated. (auth)

10122 CAPTURE OF μ^--MESONS BY THE O^{16} NUCLEUS. I. S. Shapiro and L. D. Blokhintsev. Zhur. Eksptl'. i Teoret Fiz., 39: 1112-14(Oct. 1960). (In Russian)

The ratio of the probabilities for μ^- capture by the O^{16} nucleus with formation of N^{16} in the 0^- and 1^- states was calculated. It was found to be strongly dependent on the effective pseudoscalar constant and can be used for its measurement. (auth)

10123 NEW METHOD OF γ RADIATION IDENTIFICATION IN (p,p'γ), (p,γ), and (p,nγ) REACTIONS. A. K. Val'ter, I. I. Zalyubovskiĭ, A. P. Klyucharev, and V. A. Lutsik (Inst. of Physics and Tech., Academy of Sciences, Ukrainian, S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1159-61(Oct. 1960). (In Russian)

Investigations of nuclear level structures by the γ emission from target bombardment by low-energy protons are complicated by interference from competing reactions (p,p'γ), (p,γ), and (p,nγ). It is suggested that this competition might be to distinguish the origin of the γ radiation. For instance considering the γ yields of each observed line as a function of proton energy, at the threshold region of the (p,n) reaction it is possible to segregate the γ radiation produced by (p,p'γ) and (p,γ) reactions. The (p,n) reaction threshold for most stable isotopes is known, hence, by increasing the proton energy it is possible to investigate several isotopes in a target and separate the γ radiation from each isotope. Determinations of energy levels in (p,nγ) reactions may be made by reversing the procedure. As an example the method is applied in the investigation of γ radiation of Co^{59}(p,nγ)Ni^{59} and Cu^{65}(p,nγ)Zn^{65} reactions and the excitation functions for γ rays at 770 kev and 1015 kev from Zn^{65} and at 465 and 1330 kev for Ni^{59} are plotted. (R.V.J.)

10124 ON THE INTENSITY OF NONRADIATIVE TRANSITIONS IN μ-MESIC ATOMS. M. Ya. Balats, L. N. Kondrat'ev, L. G. Landsberg, P. I. Lebedev, B. V. Obukhov, and B. Pontecorvo (Joint Inst. for Nuclear Physics, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1168-70(Oct. 1960). (In Russian)

A systematic study is made of 2P–1S transition intensities in mesic Pb, Bi, Th, U^{235}, and U^{238} and the spectra are plotted and normalized. Special attention is given to the background level. The background intensity is strongly reduced by a Cherenkov gas threshold counter, eliminating almost all electrons and reducing the number of pions in the muon beam. The background of 3D–2P transitions at a pulse amplitude corresponding to 2P–1S was measured using molybdenum and cadmium specimens. Tabulated data show identical intensities for lead and bismuth. The nuclear level density at 6 Mev is abnormally small in lead and bismuth, thus their portion of nonradiative transitions is almost nil, while in other nuclei the nonradiative effect was obvious. Fission, spallation with one neutron emission, and return to the ground state with γ emissions take place as a result of nuclear excitation by 2P–1S transitions. Nonradiative fission is impossible due to the μ^- Coulomb field and neutron emission is impossible due to energy considerations. The relatively small difference of the 2P–1S nonradiative intensity in U^{238} and U^{235} leads to an assumption that the "combined" mechanism in ground-state return plays an important part in "nonradiative transitions." (R.V.J.)

10125 ON THE PROBABILITY OF MESON CAPTURE AT VARIOUS MESIC ATOM LEVELS. S. S. Gershteĭn (Joint Inst. of Nuclear Research, Dubna, U.S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1170-4(Oct. 1960). (In Russian)

The distribution of mesic hydrogen and its influence on π- and K-meson capture from upper orbits, the time for π-meson thermalizing, and the characteristics of π- and K-meson capture by $Z > 1$ were analyzed. The probability of slow negative meson capture by atomic hydrogen was calculated considering that at distances less than $R_0 \simeq 0.64\, a_e$ ($a_e = \hbar^2/m_e e^2$) between mesons and protons the electron cannot be in a bound state. Consequently, with mesons approaching protons at R_0 distance, the electron adiabatically transfers to the solid spectrum. This leads to large meson ionization losses up to the hydrogen ionization potential (I), and at $\epsilon < I$ to capture at the nearest mesic level. Considering that in adiabatic ionization the energy losses are multiple and the incoming meson spectra are constant at energy level of I, the energy distribution at $0 < \epsilon < I$ is constant. Thus, meson capture at a level $n > n_0 = (\mu/m_e)^{1/2}$ is probably $f(n) \sim n^{-3}$. A simple evaluation based on a Messi criterion indicates meson capture is more efficient at $l \sim (\mu/m^2)^{1/2}$ and rapidly diminishes at large l. For μ mesons, the effective $l = 6$ to 7, which is in good agreement with experiments using Auger electrons. (R.V.J.)

10126 MULTIPLE PRODUCTION OF PARTICLES IN THE INTERACTION BETWEEN $>10^{11}$ eV NUCLEONS AND PHOTOGRAPHIC EMULSION NUCLEI. A. P. Zhdanov, I. M. Kuks, N. V. Skirda, and R. M. Yakovlev (Radium Inst., Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1177-85(Nov. 1960). (In Russian)

The 80 multiple-meson production events observed in an emulsion stack are analyzed by methods of mathematical statistics. The experimental results are compared with the hydrodynamical theory of particle production. Meson production due to central collisions between the nucleons and heavy nuclei is considered in particular detail. (auth)

10127 THE β^+-SPECTRUM OF Si^{27}. S. S. Vasil'ev and L. Ya. Shavtvalov (Inst. of Nuclear Physics, Moscow State Univ., U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 39: 1221-3(Nov. 1960). (In Russian)

The β^+-spectrum of Si^{27} was investigated with a lens β-spectrometer. The spectrum was found to be complex with end points at 3.65 and 1.45 Mev and intensities of 90 and 10%, respectively. (auth)

10128 INELASTIC SCATTERING OF PHOTONS ON Rh^{103} NUCLEI. O. V. Bogdankevich, L. E. Lazareva, and A. M. Moiseev (Lebedev Inst. of Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1224-28(Nov. 1960). (In Russian)

The yields of the reaction $Rh^{103}(\gamma,\gamma')Rh^{103m}$ were measured by the induced radioactivity method for various maximum bremsstrahlung energies between 5.9 and 25.5 Mev from a 30-Mev synchrotron. In this energy range the cross section for the reaction was calculated from the yield curve by Penfold and Leiss' method. The cross section has two peaks, one near the threshold of the (γ,n) reaction with an

energy of 9.3 Mev and the second at the energy of ~20 Mev. The peak cross section values are 4.8 and ~2.5 mb, respectively. The ratio of the radiative and neutron widths is estimated. (auth)

10129 ON THE NATURE OF THE FIRST EXCITED STATES OF EVEN-EVEN SPHERICAL NUCLEI. S. T. Belyaev. Zhur. Eksptl'. i Teoret. Fiz., 39: 1386-1400 (Nov. 1960). (In Russian)

Possible collective excitations are investigated and their microscopic structure is analyzed. It is shown that depending on the interaction the excitations are bound states of the particle-particle or particle-hole types. The quadrupole excitations correspond to excitations previously found by a macroscopic study. The significance of polarizability of the core is investigated. (auth)

10130 INFLUENCE OF IMPURITIES ON THE DE-HAAS–VAN ALPHEN EFFECT. Yu. A. Bychkov (Inst. of Problems in Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1401-10(Nov. 1960). (In Russian)

The influence of elastic scattering of impurities on the quantum oscillations of the magnetic susceptibility of the electron gas in metals (De Hass-van Alphen effect) was investigated by quantum field theory methods. The quasi-classical case is considered for which the condition $\hbar\omega/\zeta \ll 1$ is fulfilled, where ω is the frequency of revolution in the magnetic field and ζ is the chemical potential, a quadratic dispersion law being assumed. It is shown that if $1/\omega\tau_0 \ll \hbar\omega/\zeta$, the scattering on impurities can be described by Dingle's factor $\tau_D = 4\pi/\tau_0$ (τ_0 is the mean free path for H = 0). The situation is more involved if $1/\omega\tau_0 \simeq \hbar\omega/\zeta$. In particular, if $\zeta = \hbar\omega(N + \frac{1}{2}) + \Delta$ and $|\Delta| \leq \hbar\omega/2$, the effect of impurities can still be described by the Dingle factor provided $\hbar^2\omega^2/\zeta \ll |\Delta| \lesssim \hbar\omega/2$. In the region where $|\Delta| \simeq \hbar^2\omega^2/\zeta$, the effect of impurities is very complex. (auth)

10131 SCATTERING OF SLOW NEUTRONS IN FERRITES AND ANTIFERROMAGNETS. V. G. Bar'yakhtar and S. V. Maleev (Leningrad Inst. of Physics and Technology and Inst. of Physics and Technology, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1430-6 (Nov. 1960). (In Russian)

The cross sections for elastic scattering of neutrons in antiferromagnets and ferrites and the cross sections for neutron scattering involving the emission or absorption of a single spin wave are computed by the spin wave method. (auth)

10132 REACTION (α,t) ON Li^7, Be^9, AND Na^{23}. N. A. Vlasov, S. P. Kalinin, A. A. Ogloblin, and V. I. Chuev. Zhur. Eksptl'. i Teoret. Fiz., 39: 1468-70(Nov. 1960). (In Russian)

Reactions (α,t) on Li^7, Be^9, and Na^{23} at 40 Mev were investigated. Residual nuclei Be^8, B^{10}, and Mg^{24} were obtained in (d,n) stripping and (d,t) capture reactions. The triton spectra from reactions (d,t) were obtained by foil activation. Foils of 4 mg/cm^2 were used as targets. Typical angular distributions from (α,t) reactions and triton spectra at small angles are plotted. The angular distributions for most groups are well described by the square of Bessel's spherical function. Moreover, the magnitude of the orbital moment of captured protons agreed with the spins and parities of evaluated levels. Comparisons are made of the corresponding levels of finite nuclei in reactions (α,t), (d,n), and (d,t). (R.V.J.)

10133 ON THE RADIATION OF THE NUCLEUS IN THE PRESENCE OF IDENTICAL NONEXCITED NUCLEI. M. G. Podgoretskiĭ and I. I. Roizen (Joint Inst. of Nuclear Research, U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 39: 1473-5(Nov. 1960). (In Russian)

A variation is observed in the frequency and attenuation of radiation emitted by an excited nucleus in the presence of one or more nonexcited nuclei. The variation is studied by considering the nuclei as isotropic classical oscillators. The problem of nuclear radiation in a symmetric diatomic molecule, where the axis a is fixed in space ($a > \lambda$, where λ is the emitted wavelength), is analyzed. An auxiliary problem on oscillatory radiation in a single one-dimensional chain with a period a is utilized in deriving an expression for radiation by an excited nucleus in a crystal. (R.V.J.)

10134 ASYMMETRY IN DOUBLE MOTT SCATTERING AND ABSOLUTE MAGNITUDES OF LONGITUDINAL ELECTRON POLARIZATION. P. E. Spivak, L. A. Mikaelyan, I. E. Kutikov, and V. F. Apalin. Zhur. Eksptl'. i Teoret. Fiz., 39: 1479-81(Nov. 1960). (In Russian)

Data on longitudinal polarization of β electrons emitted in P^{32}, Sm^{153}, Lu^{177}, Ho^{166}, In^{114}, and Au^{198} decays show variable magnitudes (approaching 12%), indicating polarization deviations from the predicted v/c values. An accurate S-function magnitude is necessary to determine the deviation of polarization from the v/c magnitude. For this purpose measurements were made of the S magnitude in non-polarized electron scattering on gold. Descriptions are given of the installation and the results of measurements for energies of 245 and 290 kev and scattering angles $\theta_1 = \theta_2 = 120°$. Further measurements at 50- to 250-kev energies and 90 to 150° are under investigation and will be published later. The absolute values for longitudinal electron polarization at 300 kev $< \sigma >$ (v/c) are: P^{32}, 1.02; Sm^{153}, 0.97; Lu^{177}, 0.92; Ho^{166}, 0.91; In^{114}, 0.93; and Au^{198}, 0.94. The absolute order of error was 3.3%. The results indicate that the deviation from v/c is not an exclusive phenomenon and may be related to the structure of the nucleus. The magnitudes of deviations in the examined cases reached 8 to 9%. (R.V.J.)

10135 ELASTIC SCATTERING OF DEUTERONS BY NUCLEI. Yu. V. Gofman and O. F. Nemets. Zhur. Eksptl'. i Teoret. Fiz., 39: 1489-91(Dec. 1960). (In Russian)

The angular distributions of 13.6-Mev deuterons elastically scattered by Pb, Au, Pt, Sn, Ag, Ni, Cu, and Fe nuclei were studied. (auth)

10136 INVESTIGATION OF STRIPPING REACTIONS ON C^{12}, O^{16} AND Si^{28}. N. V. Alekseev, K. I. Zherebtsova, V. F. Litvin, and Yu. A. Nemilov (Radium Inst., Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1508-10(Dec. 1960). (In Russian)

The energy spectrum and angular distributions of protons from the reactions $C^{12}(d,p)C^{13}$, $O^{16}(d,p)O^{17}$, and $Si^{28}(d,p)Si^{29}$ were studied for proton energies from 3 to 15 Mev and 6.3-Mev bombarding deuteron energy. For this purpose a new magnetic analyzer, the multispectrograph, was employed which simultaneously yielded the energy spectra of the reaction products emitted at various angles. By comparing the shape of the angular distributions with the predictions of the stripping theory, it was possible to derive the parities, spins, and reduced widths for a number of levels of the respective final nuclei. (auth)

10137 INVESTIGATION OF THE DECAY SCHEME OF Dy^{166}. L. I. Rusinov, A. V. Borovikov, V. S. Gvozdev, G. D. Porsev, S. L. Sakharov, and Yu. L. Khazov (Leningrad Inst. of Physics and Tech.). Zhur. Eksptl'. i Teoret. Fiz., 39: 1529-33(Dec. 1960). (In Russian)

The decay scheme of Dy^{166} ($T_{1/2}$ = 80.2 hr), which is ob-

tained as a result of double neutron capture from Dy^{164}, was investigated. The types of γ transitions in the Ho^{166} nucleus with energies of 28 (M1), 54.2 (E2), and 82.5 kev (M1) were also determined. The intensity ratios for β decay from Dy^{166} to the levels of the Ho^{166} nucleus were obtained. A scheme for the lower levels of the Ho^{166} nucleus is proposed. (auth)

10138 ANGULAR DISTRIBUTION OF SHOWER PARTICLES PRODUCED IN NUCLEAR INTERACTIONS BETWEEN FAST NUCLEONS AND HEAVY NUCLEI OF PHOTOGRAPHIC EMULSIONS. S. A. Azimov, K. T. Teshabaev, L. P. Chernova, G. M. Chernov, and V. M. Chudakov (Inst. of Physics and Tech., Academy of Sciences, Uzbek SSR and Middle Area State Univ., [USSR]). Zhur. Eksptl'. i Teoret. Fiz., 39: 1534-9(Dec. 1960). (In Russian)

The angular distribution of shower particles was studied for 70 showers produced by singly charged or neutral cosmic particles with energies of 10^{10} to 10^{12} ev and possessing more than eight strongly ionizing particles. (auth)

10139 EXCITED STATES OF THE Si^{30} NUCLEUS. A. M. Romanov (Leningrad Inst. of Physics and Tech.). Zhur. Eksptl'. i Teoret. Fiz., 39: 1540-1(Dec. 1960). (In Russian)

The Si^{30} level scheme excited in the $Al^{27}(\alpha,p)Si^{30}$ reaction was determined. (auth)

10140 EFFECT OF NUCLEAR BINDING OF NUCLEONS ON THE SHAPE OF THE π-MESON ENERGY SPECTRA. V. G. Vovchenko, G. Gel'fer, A. S. Kuznetsov, M. G. Meshcheryakov, V. Svyatkovskiĭ (Joint Inst. of Nuclear Research, Dubna, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1557-70(Dec. 1960). (In Russian)

A comparative investigation of the energy spectra of π^+ and π^- mesons produced by 654-Mev protons in free p-p collisions and also in p-p and p-n collisions in deuterons and carbon nuclei was carried out with a magnetic spectrometer. A difference between the shapes of the spectra of mesons from deuterium and carbon was detected which was due to a higher degree of pair correlation of the nucleons in the carbon nuclei than in deuterons; differences in the momentum distribution of nucleons in these nuclei; and effects of secondary pion-nucleon interactions in carbon nuclei. The value 1 : 0.79 : 0.40 was obtained for the ratio of the differential cross sections for π^+ meson formation on free protons and on protons in deuterium and carbon nuclei at an angle of $\sim 90°$ in the c.m.s. of the two colliding nucleons. The π^- meson yields from deuterium and carbon per one neutron of the target nucleus, on the other hand, were found to be approximately the same. The measured value of the ratio of the π^+ and π^- meson yields for deuterium and carbon are, correspondingly, 10.3 ± 1.3 and 6.0 ± 0.8. The decrease of this ratio on going from deuterium to carbon can be explained by the appreciable contribution of the secondary exchange interaction $\pi^0 + n \rightarrow \pi^- + p$ to the yield of π^- mesons from carbon. (auth)

10141 INVESTIGATION OF THE (γ,p)-REACTION ON THE Sn^{120} ISOTOPE. Kuo Chi-ti and B. S. Ratner (Lebedev Inst. of Physics, Moscow). Zhur. Eksptl'. i Teoret. Fiz., 39: 1578-84(Dec. 1960). (In Russian)

The cross sections of the reactions $Sn^{120}(\gamma,p)In^{119}$ and $Sn^{120}(\gamma,pn)In^{118}$ were measured by recording the induced radioactivity. The cross section of the (γ,p) reaction at the peak E_{max} = (20.8 ± 0.5) Mev is (6.5 ± 0.6) mb. The integral cross sections are 28 ± 3 and (5.0 ± 1) mb · Mev for the (γ,p) and (γ,pn) reactions, respectively. A new half period of T = (2.1 ± 0.2) min was detected which corresponds to the ground state of the In^{119} nucleus. The decay scheme of the latter is presented. The results are discussed from the viewpoint of the Wilkinson model. (auth)

10142 RATIO OF CROSS SECTIONS FOR POSITIVE AND NEGATIVE PHOTOMESON PRODUCTION ON BERYLLIUM. M. I. Adamovich, N. M. Panova, V. M. Popova, and F. R. Yagudina (Lebedev Inst. of Physics, Moscow). Zhur Eksptl'. i Teoret. Fiz., 39: 1585-8(Dec. 1960). (In Russian)

The ratio of the yields of charged mesons emitted from beryllium at an angle of 90° to photon beam from 250 Mev peak energy bremsstrahlung was measured. The meson energy spectra were obtained in the range from 12 to 40 Mev. The ratio of the cross sections for π^- and π^+ meson photoproduction was found to be $\sigma^-/\sigma^+ = 1.8 \pm 0.15$. The results obtained are discussed. (auth)

10143 THE γ-SPECTRUM OF Na^{24} IN THE 2.5–5.5 MEV ENERGY RANGE. K. P. Artamonova, L. V. Gustova, Yu. N. Podkopaev, and O. V. Chubinskiĭ (Leningrad State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 39: 1593-5(Dec. 1960). (In Russian)

The hard γ radiation from Na^{24} was investigated. The previously known γ lines corresponding to the transitions $h\nu$ = 2.75 and 3.85 Mev were observed and a more precise determination of the intensity of the latter transition was made and found to equal $(9 \pm 2) \cdot 10^{-4}$ quantum per decay. Gamma rays from the transition $h\nu$ = 4.24 Mev (4230 ± 50 kev), with an intensity $(1.5 \pm 0.5) \cdot 10^{-5}$ quantum per decay, were detected. The upper limit of the intensity of the γ transition $h\nu$ = 5.22 Mev, which is possible according to the Na^{24} decay scheme was estimated at $I_{5.22} \leq 2.10^{-7}$ quantum per decay. The reduced half lives for β transitions with E_p = 0.29 and 1.27 Mev were estimated: lgft = 6.6 and 10.7, respectively. (auth)

10144 CHARGED PRODUCTS FROM THE REACTIONS He^4 + d (20 Mev). K. P. Artemov and N. A. Vlasov. Zhur. Eksptl'. i Teoret. Fiz., 39: 1612-14(Dec. 1960). (In Russian)

The spectra and angular distributions of the charged products from the reaction between 20.2 Mev deuterons and He^4 were studied with photographic emulsions. The angular distributions of elastically scattered deuterons and the protons from the reactions $He^4(d,p)He^5$ and $He^4(d,pn)He^4$ are presented. The proton group from the $He^4(d,p)He^5$ (ground state) reaction is intense at small angles. A broad continuous proton spectrum is observed at large angles. The angular distribution of the continuous spectrum protons is similar to that of the elastically scattered deuterons. The elastic scattering and (d,pn) cross sections are approximately equal. (auth)

10145 THE (d,t) REACTION ON ZIRCONIUM ISOTOPES. N. A. Vlasov, S. P. Kalinin, A. A. Ogloblin, and V. I. Chuev. Zhur. Eksptl'. i Teoret. Fiz., 39: 1615-17 (Dec. 1960). (In Russian)

The spectra of tritons produced in the (d,t) reaction on $Zr^{91,92,94}$ were studied for E_d = 20 Mev. Two groups of tritons differing with respect to energy and angular distribution were produced on zirconium isotopes. One of these groups corresponds to ejection of a neutron from the N = 50 filled shell and the other to ejection of an external neutron. The intensity of this latter group is approximately proportional to the number of super-magic neutrons. The intensity of the first group slowly decreases from Zr^{90} to Zr^{94}. (auth)

10146 THE REACTION $B^{11}(d,t)B^{10}$. N. A. Vlasov, S. P. Kalinin, A. A. Ogloblin, and V. I. Chuev. Zhur. Eksptl'. i Teoret. Fiz., 39: 1618-20(Dec. 1960). (In Russian)

The $B^{11}(d,t)B^{10}$ reaction was studied for 20-Mev deuterons. In accordance with the level scheme of the B^{10} nucleus, excitation of the lower levels of B^{10} occurred as a result of ejection of a neutron with l = 1. The probability for formation of the ground state is several times higher than that for excitation of excited states. The reduced widths for the reactions $B^{11}(d,t)B^{10}$ and $Be^{9}(d,n)B^{10}$ are compared. (auth)

10147 ON REACTIONS INVOLVING THE FORMATION OF Pb^{205m} ISOMER. V. L. Glagolev, A. M. Morozov, and P. A. Yampol'skiĭ (Inst. of Chemical Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1621-4 (Dec. 1960). (In Russian)

More accurate data relating to the short period γ radiation emitted from thallium irradiated by 19.2-Mev protons and 14.7-Mev neutrons are presented. It is demonstrated that the radiation is from the Pb^{205m} isomer. The cross sections for production of Pb^{205m} nuclei in proton and neutron reactions were measured. Calculations show that about half of the Pb^{205} nuclei produced in the $Pb^{206}(n,2n)$ reaction is formed in the metastable state. (auth)

10148 ON SECONDARY PROCESS IN THE PRODUCTION OF π-MESONS ON NUCLEI. V. M. Mal'tsev and Yu. D. Prokoshkin (Joint Inst. for Nuclear Research, Dubna, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1625-9 (Dec. 1960). (In Russian)

The production of π mesons in proton collisions on carbon at an energy of 660 Mev was calculated by the Monte Carlo method. It is shown that scattering of the π mesons appreciably changes the π meson angular distributions and ratio of the positive and negative π meson yields. The angular dependence obtained for this ratio agrees with the experimental data. (auth)

10149 ON SLOW AND FAST NEUTRON CAPTURE PROCESSES IN THE THEORY OF ORIGIN OF ELEMENTS. G. S. Malkiel. Zhur. Eksptl'. i Teoret. Fiz., 39: 1637-40 (Dec. 1960). (In Russian)

A hypothesis of the formation of elements with Z > 30 via neutron capture is discussed. It is shown that the time required for formation of stable nuclei is of the order of 100 days. Considerations are presented which indicate that neutron numbers 98, 108, and 116 may be favored. (auth)

10150 PROPERTIES OF THE SCATTERING AMPLITUDE CONDITIONED BY THE UNITARITY CONDITION. M. A. Braun and L. V. Prokhorov (Leningrad State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 39: 1641-6(Dec. 1960). (In Russian)

The restrictions imposed by the unitarity condition on the scattering amplitude for two particles were investigated. The imaginary part of the scattering amplitude was found to be a bounded function of energy and did not possess discontinuities of the first kind in the physical region of the variables. Excluding, possibly, some particular scattering angles, the amplitude could not grow infinitely as the energy tends to infinity. Under some reasonable assumptions it was found that the total scattering cross section cannot grow infinitely with growth of the energy. (auth)

10151 DETERMINATION OF THE DEFORMATION OF α-ACTIVE NUCLEI AND THEIR QUADRUPOLARIZATION ON BASIS OF THE α-PARTICLE ENERGY AND ANGULAR DISTRIBUTIONS. V. G. Nosov. Zhur. Eksptl'. i Teoret. Fiz., 39: 1660-7(Dec. 1960). (In Russian)

The α-decay theory for nonspherical nuclei developed previously was employed to treat the experimental data on the relative fine structure line intensities of the α rays, half lives, and angular distributions of α particles emitted by oriented nuclei. The dependence of the nuclear deformation on atomic weight in the region A > 220 was deduced from fine structure data. It is shown that by taking into account the effect of these deformations on the half lives it is possible to remove the discrepancies between the variation of α-active nuclear radii and the predictions of the α-decay theory. Quadrupolarization of the parent U^{233} nuclei was determined in the corresponding experiments from the angular distribution of the α particles. (auth)

10152 ON THE BOND IN THE C^{12}-C^{12} NUCLEAR MOLECULE. A. S. Kompanyeets (Inst. of Chemical Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1713-15(Dec. 1960). (In Russian)

It is shown that molecular states of two nuclei may exist as the result of a common orbit of a strongly excited neutron. (auth)

10153 CALCULATION OF l-FORBIDDEN TRANSITION PROBABILITIES. G. M. Bukat (Leningrad Inst. of Physics and Tech.). Zhur. Eksptl'. i Teoret. Fiz., 39: 1716-17 (Dec. 1960). (In Russian)

The reduced matrix elements for l-forbidden M1-transitions were calculated by employing a configuration mixture. The results of the calculations are compared with the experimental data. (auth)

10154 μ^--MESON DECAY FROM THE K-ORBIT. M. V. Terent'ev. Zhur. Eksptl'. i Teoret. Fiz., 39: 1734-6(Dec. 1960). (In Russian)

The decay $\mu^- \rightarrow e^- + \nu + \bar{\nu}$ was considered theoretically for the case when the meson is in a bound state in the K-orbit of the atom. Decay electron spectra were calculated for several elements and the μ^--meson lifetime as a function of Z was determined. The calculations were performed with an accuracy to linear terms in the parameter Z/137. (auth)

10155 CROSS SECTIONS FOR RADIATIVE CAPTURE OF NEUTRONS BY HEAVY NUCLEI. P. E. Nemirovskiĭ. Zhur. Eksptl'. i Teoret. Fiz., 39: 1737-43(Dec. 1960). (In Russian)

It is shown that at small energies (beginning from 1 kev) capture of neutrons with l = 1 play an appreciable role in the radiative capture of neutrons by heavy nuclei. Capture of neutrons with l = 1, 2, 3 predominates at energies 0.1 to 1 Mev. The optical model offers a satisfactory explanation of the experiments. In the absence of inelastic scattering the radiative capture cross section becomes constant at energies >0.3 Mev, and then increases somewhat as a result of increase of the level density. In the presence of scattering of neutrons with small values of l, the energy dependence of the radiative capture cross section is close to 1/E. (auth)

10156 ON SYMMETRY OF THE SOLUTIONS OBTAINED IN DETERMINING THE SINGULARITIES OF FEYNMAN DIAGRAMS BY LANDAU'S METHOD. A. Z. Patashinskiĭ (Siberian Branch, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1744-6(Dec. 1960). (In Russian)

It was proved that for some Feynman diagrams the solutions obtained by Landau's method for determining the position of the singularities are symmetric. (auth)

10157 PHOTODISINTEGRATION OF THE He^4 NUCLEUS AT HIGH ENERGIES. R. I. Dzhibuti and A. V. Tagviashvili (Tbilisi State Univ., Georgian SSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1756-9(Dec. 1960). (In Russian)

The angular distributions and total cross sections for

photonucleons produced in the reactions $He^4(\gamma,p)H^3$ and $He^4(\gamma,n)He^3$ were deduced on the basis of the two-particle model. The results are compared with the experimental data. (auth)

10158 INELASTIC SCATTERING OF HIGH ENERGY ELECTRONS ON NUCLEI. A. G. Sitenko and V. N. Gur'ev (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1760-5(Dec. 1960). (In Russian)

Inelastic nuclear scattering of fast electrons accompanied by ejection of nucleons from the nucleus was considered. The differential cross section of the process is expressed in terms of the correlation function between nucleons due to two-particle interactions. The electron spectrum was calculated by employing the correlation function derived from data on neutron capture by nuclear protons. The spectrum agrees with the experimental data. (auth)

10159 BREMSSTRAHLUNG OF SLOW ELECTRONS DECELERATED BY NEUTRAL ATOMS. O. B. Firsov and M. I. Chibisov. Zhur. Eksptl'. i Teoret. Fiz., 39: 1770-6 (Dec. 1960). (In Russian)

The bremsstrahlung cross section for slow ($E_{el} < 3$ ev) electrons colliding with neutral atoms is expressed in terms of the cross section for elastic scattering of electrons on atoms. The absorption coefficient of the radiation was determined. The range of gas temperatures and pressures in which collisions between the electrons and atoms yielded the largest contribution to the radiation is indicated. (auth)

10160 THE POLARIZATION AND ANGULAR DISTRIBUTION OF NEUTRONS EMITTED IN μ-CAPTURE FROM SOME LIGHT NUCLEI. M. K. Akimova, L. D. Blokhintsev, and E. I. Dolinskiĭ (Moscow State Univ.). Zhur. Eksptl'. i Teoret. Fiz., 39: 1806-17(Dec. 1960). (In Russian)

The energy spectra, angular distributions, and polarization of neutrons of the direct process produced in μ capture by C^{12}, Ne^{20}, Si^{28}, and S^{32} nuclei were calculated. The calculations were based on an effective μ-capture hamiltonian which takes into account relativistic effects of the first order in v/c for nucleons, including weak magnetism and effective pseudoscalar interaction. The state of protons in the nucleus is described by the nuclear shell model with jj coupling. Interaction between the emitted neutrons and the nucleus was taken into account by help of the optical model. The results are compared with the experimental data. (auth)

10161 POLARIZATION PHENOMENA IN THE COMPTON EFFECT. G. V. Frolov (Radium Inst., Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1829-36(Dec. 1960). (In Russian)

Expressions for all coefficients characterizing polarization phenomena in the Compton effect were derived in terms of form factors entering the scattering amplitude. Relations between these coefficients were established which are due to invariance of the scattering amplitude with respect to time inversion and to crossing symmetry. The relations derived have a relativistically invariant form. The results obtained were employed to compute the polarization of recoil electrons produced in the scattering of unpolarized photons on unpolarized electrons. (auth)

10162 KINETIC ANALYSIS OF CHAIN REACTIONS. VI. TRANSFORMATION OF THE FORM OF SOLUTION OF THE BASIC EQUATIONS OF CHAIN REACTION KINETICS FOR THE CASE OF THREE ACTIVE PARTICLES. S. S. Vasil'ev (Technological Inst. of Heavy Industry, Moscow). Zhur. Fiz. Khim., 34: 2174-83(Oct. 1960). (In Russian)

It was shown that for the case of a chain reaction with participation of three active particles (labeled by the indexes i = 1, 2, and 3 or j = 1, 2, and 3), the integrals of the initial system of differential equations, taking into account the symbols introduced, may be represented in the form of the kinetic expressions which contain the generalized kinetic constants of reaction of the particles s_i, the mathematical expectation of their regeneration ω_{ij}, the rates of the spontaneous appearance of the particles u_i, the initial concentrations of the particles $n_i^{(0)}$, and the roots $\varphi^{(m)}$ (m = 1, 2, 3) of the characteristic cubic equation. The relations derived allowed direct observation of how the quantities s_i, ω_{ij}, u_i, and $\varphi^{(m)}$ affect the course of change in concentrations of the active particles. Particular solutions are discussed, illustrating the application of the derived correlations for various conditions of occurrence of chain reactions. (auth)

10163 KINEMATICS OF NUCLEAR REACTIONS. A. M. Baldin, V. I. Gol'danskiĭ, and I. L. Rozenthal. Translated from "Kinematika Yadernykh Reaktsiĭ" by William E. Jones. New York, Pergamon Press, 1961. 313p. $6.50.

Both the classical and quantum kinematics of nuclear reactions are summarized. The discussion includes some of the basic characteristics of motion at relativistic velocities, effective cross sections, effective cross-section transformation due to change of the co-ordinate system, collisions and decays involving two or more secondary particles, the scattering matrix and its properties, collisions of particles possessing spin, polarization of particles in nuclear reactions, and reactions involving photons. Also included are details of graphical construction methods for kinematics of reactions, graphs for the relationships between angles and energy for widely investigated interactions involving light nuclei or elementary particles, and tables of Clebsch-Gordon, Racah, X, Z, and Z_γ coefficients. (M.C.G.)

Particle Accelerators

10164 (AERE-M-773) 7 GeV PROTON SYNCHROTRON (NIMROD) POWER SUPPLY AND CONTROL CIRCUITS FOR MAGNET MODELS AC1. AC2. AND AC3. A. J. Holt (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Nov. 1960. 15p.

The motor-generator power supply and control circuits for the NIMROD synchrotron are described. These components are used to obtain pulsed and steady magnetic fields using magnet models AC1, 2, and 3. (auth)

10165 (BNL-5035) COSMOTRON ORBIT SHIFTER. A. Tranis (Brookhaven National Lab., Upton, N. Y.). Sept. 19, 1960. 5p.

The function of the orbit shifter is to correct the radial first harmonic in the Cosmotron magnetic field. This is achieved by injecting an approximately linear ramp of current into four turns of the pole face windings. The system that constitutes the necessary circuitry and timing controls to obtain the correct current waveform is described. (W.D.M.)

10166 (BNL-5036) POWER REQUIREMENTS FOR MAGNETS & BUBBLE CHAMBERS IN COSMOTRON DEPARTMENT. A. C. Nerenbert (Brookhaven National Lab., Upton, N. Y.). Sept. 27, 1960. 2p.

A table is presented which indicates the power requirements for the existing magnets and bubble chambers and those units on order for the Cosmotron Department. (W.D.M.)

10167 (CERN-60-42) OPERATION AND DEVELOPMENT QUARTERLY REPORT NO. 3, JULY–SEPTEMBER 1960 (European Organization for Nuclear Research, Geneva). Nov. 17, 1960. 24p.

A study was made of random variations of r-f levels and phases during operation and of their effects on beam mean energy and energy spread. The grid control equipment of the static converters was modified in order to improve "Flat-Top" operation. The trapping behavior with early beam control take-over was investigated. Various new target shapes were tried in an attempt to obtain better spot geometry and longer counter bursts. The extra skewed quadrupole windings for cancelling the coupling between vertical and horizontal betatron oscillations were added to the octupole lenses. (For preceding period see CERN-60-29.) (W.L.H.)

10168 (CF-59-6-10) COUPLED TRANSMISSION LINES. R. E. Warsham and S. W. Mosko (Oak Ridge National Lab., Tenn.). June 2, 1959. 13p.

Tests on a coupled transmission line resonator show that a fairly accurate value of the coupling coefficient can be predicted by considering line geometry. The measured values of V_{02} and I_{02} appear to agree with predicted values. Development of a resonator for ORIC with two coupled transmission lines is under way. (W.L.H.)

10169 (CF-59-6-18) ORIC R-F MODEL III PROGRESS REPORT. R. E. Worsham and S. W. Mosko (Oak Ridge National Lab., Tenn.). June 2, 1959. 36p.

A model was made of the resonator of the Oak Ridge Relativistic Isochronous Cyclotron to check the calculations for the frequency range and excitation power of the resonator. A description is given of the r-f system with a tabulation of its general specifications. Calculations of the properties of the model are given, followed by data from measurements of the model characteristics. The power loss in the model was found to be ~50% greater than the calculated loss of 230 kw. Corrections were suggested which would make it possible to approach the predicted power loss. (B.O.G.)

10170 (MSUCP-3) RAPID TRAVERSAL OF 3/3 RADIAL RESONANCE NEAR THE CENTER OF A SECTOR FOCUSED CYCLOTRON. J. E. Stover (Michigan State Univ., East Lansing). August 1960. 67p. Contract AT(11-1)-872.

The feasibility of overcoming axial defocusing at small radii for a three-sector magnetic field was investigated. The procedures used involved numerical construction of an average magnetic field to supplement the axial focusing in the central region, and a feasibility study of the traversal of the radial oscillation resonance necessitated by features of this average field. For the numerical calculations formulas obtained from the smooth approximation are used. The orbital properties of ions were obtained on the MISTIC computer. It was found that good axial focusing can be obtained near the center of a sector-focused cyclotron from a nonisochronous average magnetic field without excessive phase slip. Ions accelerated in the field described must traverse the 3/3 radial resonance near the center of the cyclotron. Orbital integration with a digital computer showed that a ½-in.-wide proton beam with an energy gain per revolution of 280 kev can be accelerated through this resonance without intolerable beam distortion. (T.R.H.)

10171 (MURA-410) CARE AND FEEDING OF THE ULTRAHIGH VACUUM SYSTEM OF THE TWO-WAY MODEL. R. H. Bieri (Midwestern Universities Research Assn., Madison, Wis.). June 20, 1958. 3p. Contract AT(11-1)-384.

Some brief suggestions concerning the handling of the ultrahigh vacuum system built at Midwestern Universities Research Association are given. The mercury pump, cleaning of traps, baking procedure, and outgassing are discussed. (W.D.M.)

10172 (MURA-426) RF PROGRAM FOR THE 40 MEV TWO-WAY ELECTRON MODEL. L. H. Johnston, D. A. Swenson and E. M. Rowe (Midwestern Universities Research Assn., Madison, Wis.). Aug. 22, 1958. 14p. Contract AT(11-1)-384.

The characteristics of the r-f system for the 40-Mev two-way electron model are given. Two possible modes of operation, along with parameters pertinent to each mode, are discussed. The scattering of the stacked beam by r-f buckets is treated. A graph is presented of the energy, frequency, gap voltage, bucket area, effective radius of electron orbit, phase oscillation frequency, and stable phase angle as a function of time for one of the modes of operation. (auth)

10173 (MURA-430) COMPARISON OF 10 AND 15 BEV TWO-WAY FFAG ACCELERATOR DESIGNS. Lawrence W. Jones (Midwestern Universities Research Assn., Madison, Wis.). Aug. 27, 1958. 11p. Contract AT(11-1)-384.

Symmetric radial sector FFAG accelerators of 10 and 15 Bev with the same N and k are compared. Except for transition energy problems, the 10-Bev design is only slightly better than the 15-Bev design in terms of space charge limits, etc. It appears that such a 10-Bev accelerator installation would cost two-thirds the cost of the 15-Bev installation. (auth)

10174 (MURA-592) A PROPOSAL FOR THE STUDY OF LONG-TIME STABILITY. G. Parzen (Midwestern Universities Research Assn., Madison, Wis.). Oct. 17, 1960. 8p. Contract AT(11-1)-384.

A method is proposed for studying the stability of a classically moving particle over long periods of time. The method is based on some observations made by Feynman in presenting a space-time formulation of quantum mechanics. The stability is related to a multidimensional integral which, it is suggested, may be evaluated using a Monte Carlo procedure. (auth)

10175 (NYO-9359) THE SPARKER, A DEVICE TO OVERCOME THE MULTIPACTOR DIFFICULTY IN STARTING THE OSCILLATOR OF A CYCLOTRON. H. W. Fulbright (Rochester, N. Y. Univ.). Jan. 3, 1961. 8p. Contract AT(30-1)-875.

A simple device was added to the cyclotron to shock the dee system into oscillations of such an amplitude that the multipactor loading would be effective. It consists of a separate small coupling loop inside the dee stem tank near the oscillator coupling loop, oriented with its plane perpendicular to the axis of the tank. A condenser and air spark gap are connected to the loop so that a high frequency discharge through the loop occurs when a spark jumps. This induces a surge of high frequency current both in the walls of the dee tank and in the plate and grid circuits, with the result that the dee circuit begins to oscillate with a dee voltage amplitude of several hundred volts. The oscillator then begins to carry the voltage on up to its full value. (W.L.H.)

10176 (TID-6992) QUARTERLY REPORT OF THE DIRECTOR FOR THE PERIOD JULY 1, 1960, TO SEPTEMBER 30, 1960. Bernard Waldman (Midwestern Universities Research Assn., Madison, Wis.). 14p Contract AT(11-1)-384.

Progress is described on the Two-Way Model, design of a 15-Bev high-intensity proton accelerator, advanced re-

search, and bubble chamber. The Midwestern Universities Research Association proposal to AEC for the proton accelerator is outlined. (T.R.H.)

10177 (TID-11499) ANNUAL PROGRESS REPORT FOR PERIOD DECEMBER 1959 THROUGH NOVEMBER 1960. (Minnesota. Univ., Minneapolis. Linear Accelerator Lab.). Nov. 1960. 125p. Contract AT(11-1)-50.

Modifications on the Minnesota Proton Linear Accelerator are reported. Experimental equipment that were added to the accelerator system include a polarized ion source, magnetic spectrometer, polarized proton target, and accessory apparatus for polarized scattering measurements. Angular distributions of p-p scattering were made at 10, 26, 40, and 68 Mev, and the 90° cross section was measured continuously as a function of energy at 28 to 68 Mev. The chamber designed to investigate small angle scattering at 10 Mev is installed and aligned; the pressure balance and pressure regulator for use with gas targets at ~1 mm pressure were built and are being tested. In proton-nucleus reactions, a proton-deuterium reaction chamber was completed and the electronic apparatus tested. Coincident protons were observed using a deuteron gas target. Other experiments which are being conducted include angular distributions of α particles in p,α reactions, inelastic proton scattering at small angles, and proton total reaction cross section at 9 Mev. Activities associated with, and parameters used in a program to develop a mass-sensitive particle detector are outlined. An experimental ion source is being developed for production of polarized protons. A maximum proton polarization forty times greater than the thermal equilibrium value near 3200 gauss and 1.3°K was observed in high density polyethylene bombarded by fast neutrons. Construction of a polarization analyzer for use in study of protons is in progress, and designs of transistorized triple-coincidence anti-coincidence circuits, a preamplifier, and a 22-channel pulse height analyzer are described. Research was conducted on the many-body problem, nuclear structure and reaction theory, and quantum field theory. Considerable time was spent on calculation of nuclear stripping cross sections, and analysis of electron and nucleon scattering from nuclei employing approximation techniques as well as in structure and reaction problems involving nuclei. (For preceding period see TID-5767.) (J.R.D.)

10178 (UCRL-6010) THE EFFECTS OF SPACE CHARGE AND RELATIVITY ON THE SHAPES OF CHARGED-PARTICLE BEAMS. Norris W. Hetherington and Cornelius H. Woods (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 5, 1960. 22p. Contract W-7405-eng-48.

For the case of steady, relativistic, circular, charged-particle beams having uniform density of charge over the cross section, the beam radius as a function of the longitudinal distance was calculated for ordinary, partially neutralized, and fully neutralized beams. The neutralized beams are assumed to be stable and are shown to exhibit a periodic structure. The shapes of ordinary beams in an accelerator are given. (auth)

10179 THE EFFECTIVENESS OF A WAVEGUIDE AS THE ACCELERATING SYSTEM OF AN ELECTRON SYNCHROTRON. A. N. Didenko and E. S. Kovalenko. Atomnaya Energ. 10: 69-71(Jan. 1961). (In Russian)

The efficiency of a waveguide as an accelerating system in an electron synchrotron was analyzed, neglecting wave-space harmonics and the effects of transverse field structure. The phase and group velocities, the damping α, and bond resistance R_{bond} were used to determine the complete shunt resistance R_{shunt}. In turn, R_{shunt} expresses the efficiency of the high-frequency system. The economic index of a high-frequency system with a closed-diaphragm waveguide was compared with that of large synchrotron systems. A waveguide with the parameter $R_{bond} = 50$ ohm, $Q_{eff} = 10^4$, and $v_{bound} = 0.1$ c can be obtained under good conditions. The results of numerical solutions for various multiplicities m_2/m, are plotted. (R.V.J.)

10180 BEAM STABILITY OF A 20 MEV BETATRON. D. Greene (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Brit. J. Radiol., 34: 129-32(Feb. 1961).

It is shown that the x-ray beam from a betatron moves continuously with respect to the magnet. The rate of movement is small, but it is sufficient to raise significant dosimetric problems. It is thought that the effect is associated with thermal expansion of the magnet. A servomechanism that keeps the collimator and flattening filter centered on the beam is described. (auth)

10181 METHOD OF MEASURING RELATIVE FIELD GRADIENT. Ladislav Šípek (Inst. of Vacuum Electronics, Czechoslovak Academy of Sciences, Prague). Československ. časopis pro fysiku, 10: 471-6(1960). (In Czech.)

A simple universal method is described for exact measurement of the relative gradient of rotationally symmetrical and plane fields. The universality of the method consists in the possibility of applying its principle to both direct and alternating fields, electric and magnetic. Moreover, it can be used as a basis for constructing an instrument for measuring the relative field gradient which indicates directly. The method was successfully applied in measuring the index of the alternating magnetic field of a betatron. (auth)

10182 MEASUREMENT OF DISTRIBUTION OF CURRENT DENSITY IN ELECTRON BEAMS. M. Štícha (Charles Univ., Prague). Československ. časopis pro fysiku, 10: 477-9(1960). (In Czech.)

A method is described by which quantitative measurement may be made of the distribution of current density in electron beams. The method uses a diaphragm with a pin hole, oscillating across the beam. The current passing through the pin hole is proportional to the current density, if the pin hole is small compared with the dimensions of the beam. The distribution of the current density is shown on the screen of the oscillograph. (auth)

10183 THE INFLUENCE OF THE TRANSITION REGION OF A MAGNETIC FIELD ON TURBULENT ELECTRON BEAMS. Jiřina Vejvodová (Charles Univ., Prague). Ceskoslov. časopis pro fysiku, 10: 480-3(1960). (In Czech.)

The trajectories of electrons in the transition region were derived in the first and second approximation. It is shown that the turbulence of the beam does not originate in the transition region but that the latter influences the distribution of the radial components of the velocities. (auth)

10184 BETATRON OSCILLATIONS IN AN ACCELERATOR WITH A GENERAL FIELD. II. J. Teichman (Institute of Vacuum Electronics, Czechoslovakian Academy of Science, Prague). Czechoslov. J. Phys., B10: 722-36 (1960). (In Russian)

The dynamics of particles in a stationary approximation, without acceleration, were solved in the second part of the theory of an accelerator with a generalized field. The trajectories of the particles in the neighborhood of the equilibrium orbit were related to it as betatron oscillations. An analysis of betatron oscillations included the region of

stability determined by means of Routh-Hurwitz criterion, damping, resonance effects, and field perturbations. A general matrix method is presented permitting the inclusion of all the focusing structures used in accelerators. (auth)

10185 SUPPLY OF THE CONSTANT CURRENT ELECTROMAGNETS AT SATURNE. Michel Cambornac. Inds. atomiques, 4: No. 9-10, 71-5(1960). (In French)

The constant current electromagnets at Saturne are described. Fourteen supply units were constructed. They distribute power between 100 and 300 kev with a precision of better than one thousandth. After a description of the principles and the materials used, the difficulties found during adjustment and the solutions used are reviewed. (tr-auth)

10186 THE BROOKHAVEN ALTERNATING GRADIENT SYNCHROTRON. John P. Blewett (Brookhaven National Lab., Upton, N. Y. and Associated Universities, Inc., New York). IRE Intern. Conv. Record, 8: Pt. 9, 3-10(1960).

In the synchrotron, nuclear particles are accelerated to energies of several billions of electron volts. Alternating gradient focusing has brought economies to the synchrotron art which make practicable the attainment of energies in the tens of billions of electron volts. The alternating gradient proton synchrotron now nearing completion at the Brookhaven National Laboratory is described. When this machine comes into operation it will yield 30-Bev protons – this energy will be the highest available anywhere in the world. The basic operating principles and parameters of the Brookhaven machine are discussed. (auth)

10187 THE LINEAR ACCELERATOR INJECTOR FOR THE AGS. S. Giordano (Brookhaven National Lab., Upton, N. Y. and Associated Universities, Inc., New York). IRE Intern. Conv. Record, 8: Pt. 9, 11-18(1960).

The linear accelerator that is described is to be used as a proton injector for the Brookhaven Alternating Gradient Synchrotron (AGS). The acceptance requirements of the AGS will therefore determine the specifications of the injection system. The injection system must supply a pulse of protons 7 μ long, having an energy of 50 Mev ±2% and an angular spread of less than ±2 milliradians; it should contain at least 10^{11} protons. A cold cathode hydrogen discharge supplies the initial protons to be accelerated. The preinjector, which is a Cockcroft-Walton 5-stage d-c power supply, accelerates the protons to an energy of 750 kev. This 750-kev beam is then injected into a linear accelerator, where its energy is increased to 50 Mev. The linear accelerator is a cylindrical r-f structure ~90 cm in diameter and 33 m long, containing 124 drift tubes through which the beam must pass. To focus the proton beam, pulsed quadrupole magnets are located inside the drift tubes. To tune the linear accelerator to the proper mode and establish the correct field pattern, various tuning devices and pick-up probes are included in the structure. The over-all structure must then be temperature-controlled to within ±0.01°C. A 200-Mc-pulsed r-f source is used to excite the linear accelerator in a TM_{110} mode. The r-f pulse has a peak power of 5 Mw, a width of 200 μsec, and a repetition rate of 5 pps. The outputs of two separate amplifiers (each amplifier is a coaxial structure using a type TH 470 tube) are coupled together with a waveguide magic "T." The output arm of the magic "T" is coupled to the linear accelerator with a 9-in. coaxial line. The linear accelerator can only accept protons during part of the r-f cycle. A buncher cavity is placed between the pre-injector and the linear accelerator, and its function is to pre-bunch the proton beam to match the entrance requirements of the linear accelerator. A debuncher is used at the output end of the linear accelerator to reduce the energy spread of the proton beam. (auth)

10188 THE RADIO FREQUENCY ACCELERATING SYSTEM FOR THE BROOKHAVEN ALTERNATING GRADIENT SYNCHROTRON. M. Plotkin (Brookhaven National Lab., Upton, N. Y. and Associated Universities, Inc., New York). IRE Intern. Conv. Record, 8: Pt. 9, 19-27(1960).

The proton beam in the AGS is accelerated to its final energy of 30 Bev by means of a r-f accelerating system. The particles are injected into the machine at an energy of 50 Mev at which time they are traveling at one-third the velocity of light. At 30 Bev they are essentially moving with light velocity, necessitating an accelerating system which can stay in synchronism with the particles as their revolution frequency varies by a factor of three. The frequency range covered is 1.40 to 4.5 mc/sec. A low-level r-f system detects the correct frequency from the beam itself, corrects the phase so that the particles are accelerated properly and in turn drives a central driver amplifier. This unit is an eight-stage broad-band video amplifier capable of delivering an output of 80 kw. This driver feeds 12 accelerating stations, each consisting of a 25-kw push-pull amplifier and a tuned ferrite-loaded accelerating cavity. The cavity is kept continuously tuned by means of a saturating current used to vary the ferrite permeability. The saturating supply utilizes a transistor amplifier capable of delivering and controlling 1000 amp. It is a portion of a closed tuning loop which ensures that the load on the final amplifier is kept at resonance. Owing to the frequency change by a factor of three to one, it was necessary to develop a means to correct for the incremental phase shift inherent in the thousands of feet of coaxial cable required for the system. In addition, amplifiers had to be built which would automatically tune to a desired varying frequency in the output of a mixer circuit where the sum frequency, difference frequency, and one of the input frequencies were all relatively close together. These circuits are described. (auth)

10189 ANGULAR DISTRIBUTION AND POLARIZATION OF THE RADIATION EMITTED BY ELECTRONS ACCELERATED IN A SYNCHROTRON. D. E. Bedo, D. H. Tomboulian, and J. A. Rigert (Cornell Univ., Ithaca, N. Y.). J. Appl. Phys., 31: 2289-93(Dec. 1960).

Evaluations of the angular distribution of the synchrotron radiation for a high-energy accelerator are presented. The investigation indicates that the peak power, at wavelengths in excess of a certain critical value, does not occur in the orbital plane but at some angle above or below this plane. Expressions are given for the intensity components of the radiation polarized at right angles to, and in the plane of the orbit, respectively. The radiation emitted by a monoenergetic electron is, in general, elliptically polarized, the ratio between the major and minor axes depending on the angle ψ between the direction of observation and the orbital plane. For $\psi = 0$ the radiation is linearly polarized and approaches circular polarization with increasing values of ψ. (auth)

10190 ENGINEERING FOR PARTICLE LAUNCHING. F. R. Paulsen. Nuclear Energy, 29-32(Jan. 1961).

Research and development work on particle accelerators is reviewed. The Van de Graaf, linear, insulating core transformer, Magnaline or transmission line, and the Tandem Van de Graaf accelerators are described. High-voltage ion sources and magnetic optics, which can produce pulsing of accelerators from 1 msec down to a few millimicroseconds, are discussed. The development of an isotope sepa-

rator producing 10 ma of particles in the mass range 1 to 400 with a resolving power of 400 is summarized. The uses of these accelerators are also reviewed. (M.C.G.)

10191 PHASE- AND VERTICAL STABILITY OF MICROTRONS. É. Kisdi-Koszó and L. Turi (Central Research Inst. for Physics, Budapest). Nuclear Instr. & Methods, 9: 137-40(Nov. 1960). (In English)

The phase and vertical stabilities of an 8-orbit 2-Mev microtron were investigated and it is found that owing to the poor phase stability only 7% of the current intensity remains available for acceleration. The vertical drift caused further losses amounting to 90% of the current intensity. The actual output of the apparatus was 0.4% of the electron current fed into the first orbit. A simple method is proposed for improving the phase stability. (auth)

10192 THE LIVERMORE VARIABLE-ENERGY 90-INCH CYCLOTRON. H. P. Hernandez, J. M. Peterson, B. H. Smith, and C. J. Taylor (Univ. of California, Livermore). Nuclear Instr. & Methods, 9: 287-302(Dec. 1960). (In English)

A variable-energy cyclotron is described which accelerates protons from 2.6 to 15 Mev, deuterons from 5.2 to 12.5 Mev, and α particles from 10.4 to 25 Mev. The 90-in.-diameter magnet incorporates a special fringing field to reduce the angular divergence of the emerging beam. The single dee is driven by a crystal-controlled power amplifier, variable in steps of 55 kc/sec from 4.0 to 9.5 Mc/sec. The internal beam is limited to 200 μA to avoid septum damage, and 15 to 25% of this beam can be extracted. The external beam has a 2% total spread in energy, and an individual pulse in the beam has a time spread of 2% of the radiofrequency period. Most of the external beam is contained in an elliptical cone with half angles of 0.30 and 0.15°. (auth)

10193 MICROWAVE SEPARATOR FOR HIGH ENERGY PARTICLE BEAMS. P. R. Phillips (Stanford Univ., Calif.). Rev. Sci. Instr., 32: 13-16(Jan. 1961).

The design and construction are described of a microwave separator for high-energy particle beams, following the original ideas of Panofsky and Wenzel. A TM_{012} rectangular cavity with a Q of 15,000 and a maximum power dissipation of 1.3 Mw(megawatts) was used. With this electrons of 150 Mev/c momentum through $^3/_4$ in. at the final focus of the analyzing magnet could be deflected. The available aperture is so small that the technique is not immediately useful, but it is anticipated that it may become so at higher energies, when other methods of beam separation become unfeasible. (auth)

10194 SIMPLE METHOD OF REPAIRING A CRACKED GLASS ACCELERATOR TUBE. H. Janzen and B. W. Sargent (Queen's Univ., Kingston, Ont.). Rev. Sci. Instr., 32: 91(Jan. 1961).

Repair of a cracked glass accelerator tube is described. The crack was terminated by drilling small holes with an Airbrasive unit. Then the crack was grooved by the drill, and the holes plugged with pyrex plugs. Crack and plugs were filled with a mixture of Araldite CN-503 resin, Thiokol LP-3 polymer, and triethylene tetramine hardener (10:5:1). The area was then wrapped with resin-soaked glass cloth. In six years' operation at pressures of 2 to 3 mμ Hg no leak has occurred. (T.R.H.)

10195 PROCEDURE FOR MAKING INTENSE SOURCES IN AN ELECTRON SYNCHROTRON. A. J. Bureau and C. L. Hammer (Ames Lab., Ames, Iowa). Rev. Sci. Instr., 32: 93-4(Jan. 1961). (IS-160)

An improved method for irradiating samples internal to a synchrotron or betatron vacuum chamber is described. Excitation of the one-half integral resonance is used to increase the betatron oscillations instead of using the instability near the edge of the field guide. Thus the beam can be placed on the thimble even if it is at a larger radius than the injector because of the azimuthal dependence of the growth of the betatron oscillations. Furthermore, a much larger extent of the thimble can be irradiated. (T.R.H.)

10196 A HIGH CURRENT MICROTRON. S. P. Kapitsa, V. P. Bykov, and V. N. Melekhin (Inst. of Problems in Physics, the Academy of Sciences, U.S.S.R.). Zhur. Eksptl i Teoret Fiz., 39: 997-1000(Oct. 1960). (In Russian)

Some preliminary data are presented concerning a new efficient cyclic accelerator of electrons for energies of 5 to 15 Mev. The accelerator is of the electron cyclotron type. The efficiency of electron capture onto resonance orbits and also the general efficiency of the accelerator were found to be appreciably increased by injecting the electrons from a hot cathode located directly in the resonator. The energy and momentum spread of the accelerated electrons was not large. (auth)

10197 IMPROVEMENTS RELATING TO CHARGED PARTICLE ACCELERATORS. Douglass Percival Ramsay Petrie and Stanley Ernest Hunt (Associated Electrical Industries Ltd.). British Patent 859,149. Jan. 18, 1961.

A charged particle accelerator was designed in which undesired negative currents are prevented. The accelerator comprises annular accelerating electrodes encircling the particle path and divided into groups with the apertures of each group increasing in size progressively along the direction of movement of negative particles. Stray electrons are trapped by the small apertures at the junctions between groups. Two embodiments of this accelerator are given for acceleration of positively and negatively charged particles. (D.L.C.)

Plasma Physics and Thermonuclear Processes

10198 (AERE-R-3486) ON THE DETERMINATION OF MAGNETIC FIELDS IN SLABS AND CYLINDERS BY MEASUREMENT OF THE TIME-OF-FLIGHT OR DISPLACEMENT OF MONOENERGETIC IONS WHICH ARE PROJECTED AWAY FROM THE WALL AND RETURNED BY THE MAGNETIC FIELD. R. T. P. Whipple (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1960. 101p.

The components B_x and B_y of a static magnetic field (B_x, B_y, O), which is a function of Z only, can be determined by the use of monoenergetic ions projected into the field in various directions from a source on the wall Z = 0 and returned to the wall by the magnetic field. The source might be a radioactive emitter, such as polonium or Cm^{242}, in which case the ions would be α particles. Use may be made of either the time-of-flight measurements (T) or the components x, y of the distances between the point of emission and return, expressed as functions of the direction cosines p_x, p_y of the angle of emission of the ions. The solution of the integral equation that expresses T, or x and y, in terms of the vector potential (A_x, A_y, O) and the direction cosines p_x, p_y is simple in principle, but care must be used in applying the solution since a direction cosine cannot have a value exceeding unity. The corresponding problem is solved for helical magnetic fields inside a cylinder. Consideration is given to the application of the analysis to a

particular model. It is concluded that the experimental difficulties would be so great that, without modification, this cannot be regarded as a practical method of determining fields. (auth)

10199 (AFOSR-TN-59-445) A FURTHER NOTE ON HYPERSONIC STAGNATION POINT FLOW WITH A MAGNETIC FIELD. Research Report 53. Nelson H. Kemp (Avco Mfg. Corp. Avco Research Lab., Everett, Mass.). Apr. 1959. 18p. Contract AF49(638)-61. (AD-214807).

An inviscid flow model is described for which only the vorticity equation was solved to find the effect of the magnetic field on the shock layer flow. The results for detachment distance and velocity, and pressure gradient are given graphically. The calculations indicate that the assumption that the pressure gradient is unaffected by the magnetic field is approximately correct under certain conditions. An analysis was made of the axisymmetric incompressible stagnation point boundary layer with constant magnetic field normal to the body, which showed that neither three-dimensionality nor compressibility has a significant effect on the heat transfer rate parameter ratio, while the viscous shear stress parameter ratio shows some effect of three-dimensionality but none of compressibility. A method is described for the calculation of the reduction in heat transfer rate and viscous shear stress caused by a magnetic field normal to the body. (B.O.G.)

10200 (ARL-TR-60-274(Pt.I)) THEORY OF PLASMAS. PART I. R. K. Osborn (Michigan. Univ., Ann Arbor). Aug. 1960. 69p. Project No. 7073. Contract AF33(616)-5585.

A portion is presented of an attempt to develop, in u-space, a unified theory of plasmas—the main purpose being to localize points of difficulty or obscurity encountered in the deduction of a description of such systems. Within the context of nonrelativistic particle dynamics, exact relations describing the particle and photon singlet densities are deduced. It is shown that the relations governing the particle densities are crudely reducible to Boltzmann's and/or Vlasov's equations in the sense of certain reasonably clearly stated, but ill-evaluated, approximations. The relation describing the photon singlet density is discussed in considerable detail, and a reduction to the conventional equation of photon transport is accomplished. (auth)

10201 (CF-59-3-70) TRAPPING OF ENERGETIC IONS BY NEUTRALIZATION OF A POLARIZED BEAM. J. S. Luce (Oak Ridge National Lab., Tenn.). Mar. 17, 1959. 7p.

Recent experiments show that a positive ion beam with a density exceeding 10^8 ions/cm^3 will neutralize its space charge by trapping electrons within the beam. This trapping of electrons converts the ion beam to a neutral plasma suitable for injection and polarization experiments in a cross magnetic field. The ion energy used is about 500 volts. The beam moves readily across the magnetic field due to polarization of positive and negative charges. To create a hot plasma, it will be necessary to use higher energy ions, increase beam density, and retain neutralization by trapped electrons. (W.L.H.)

10202 (CF-60-11-50) PLASMA ACCUMULATION IN A DEVICE FED BY ENERGETIC ION TRAPPING. R. J. Mackin, Jr. (Oak Ridge National Lab., Tenn.). Nov. 10, 1960. 30p.

Simon has given a general steady-state theory of plasma accumulation (without energy losses) in an OGRA device. Such a device is fed by the injection of energetic molecular ions which dissociate to produce trapped protons. Initial trapping is achieved by dissociation in the background gas. Such a device is usually characterized by a critical input current of critical plasma density (a function of input current) above which plasma density builds up to a value limited by Coulomb-scattering losses. For a regime of operation of current interest at Oak Ridge National Laboratory (600-kev hydrogen molecular ion injection and dissociation, highly efficient ion-pumping action of the trapped plasma), extremely simple approximate formulas were derived which describe with a fair degree of accuracy the critical current or density for plasma build-up. More accurate formulas were derived which describe overlapping segments of the density-current curve to about 10% for a broad range of parameters. In every case, simple expressions for the critical currents result. The analysis was applied to a system in which initial trapping is accomplished by a Luce carbon arc. Two new points emerge: (1) the critical current for plasma build-up with arc is less than previously estimated by nearly an order of magnitude if the arc is turned off slowly or if an arc of lower density is used; and (2) the critical arc density, below which plasma build-up occurs after the arc is removed, is sufficiently low that energy losses to fixed-temperature arc electrons are not significant. Also treated are the time dependence of plasma build-up, certain aspects of the impurity problem, and electron heating effects. Numerical examples are given for OGRA and DCX-2. (auth)

10203 (ERD-CRRD-TM-60-114) GENERALIZATIONS OF THE SAHA EQUATION. Edmond M. Dewan (Air Force Cambridge Research Center, Bedford, Mass.). 42p.

The Saha equation that relates temperature to ion densities is sometimes used under circumstances that do not justify the assumptions of thermodynamic equilibrium upon which it is based. Astronomers have made generalizations of this equation but unfortunately they assume thermodynamic equilibrium energy distributions for the particles and the radiation field even though these may be at different temperatures. It is interesting to know how the non-equilibrium steady-state energy distributions affect the ionization densities. A general expression relating ion densities to the radiation and particle-energy distributions is obtained. This equation reduces to Saha's equation in the limit of thermal equilibrium and gives numerical results in good agreement with other work based on entirely different considerations, thus providing a good check. It is found that under certain conditions results which differ enormously from those predicted by the Saha equation would be expected. (auth)

10204 (LAMS-2481) HYPERSONIC PLASMA THERMOCOUPLE. Theodore Cotter (Los Alamos Scientific Lab., N. Mex.). Nov. 1960. 12p. Contract W-7405-eng-36.

The hypersonic plasma thermocouple, a simple d-c electrical power supply applicable to a vehicle moving in an ionized medium, is proposed. Some model experiments verifying the basic principle are described. (auth)

10205 (NP-9524) THE STUDY OF THE UTILIZATION OF INSTABILITIES OF THE PINCH FOR PLASMA ACCELERATION. Final Technical Report. Woldemar Bötticher, Helmut Muntenbruch, and Rudolf Wienecke (Kiel. Universität). May 1, 1960. 88p. Contract AF61(052)-87.

Shock waves were produced by means of a T-shaped tube of the Kolb arrangement and a coaxial "Pinch Tube." From multiplier measurements and smear camera photographs, x-t curves were obtained. Dependence of the shock-wave velocity on position, initial pressure, and

charging energy of the capacitor was tested in hydrogen, nitrogen, and argon. Simplified assumptions permit considerations on energy and pulse by means of the results of measurements. In the case of undamped capacitor discharges, the smear photographs show effects of interaction between shock waves, which are discussed. Additional acceleration by a foreign magnetic field leads to an increase of shock-wave velocity. (auth)

10206 (NP-9741) PLASMA PHYSICS LECTURE NOTES, CHAPTER I-II. George Schmidt (Stevens Inst. of Tech., Hoboken, N. J.). 1960. 63p. (AFOSR-TN-60-1481; SIT-P24 (10/60). CHAPTERS III-IV. 80p. (AFOSR-TN-60-1482; SIT-P24a(11/60). Contract AF49(638)-156.

Lecture notes, based on a course given in 1959-60, are presented in 4 chapters as follows: (I) Introduction, (II) Motion of Charged Particles in Electromagnetic Fields, (III) Plasma Equations, (IV) Magnetohydrodynamics. (W.L.H.)

10207 (NP-9771(Pt.I)) THE NONLINEAR INTERACTION OF AN ELECTROMAGNETIC WAVE WITH AN ANISOTROPIC PLASMA LAYER. PART I. THEORY OF HARMONIC GENERATION. Research Report No. R60-1. R. F. Whitmer and E. B. Barrett (General Telephone and Electronics Labs. Inc., Palo Alto, Calif.). Aug. 30, 1960. 37p. Contract AF19(604)-4083.

The theory of electromagnetic wave propagation through an anisotropic ionized layer, including the effects of the nonlinear terms in the Boltzmann transport equation, is presented. The method of solution of the nonlinear equations involves an expansion of all of the dependent variables in a Fourier series in time. The differential equations describing wave propagation are solved for each frequency in the series, for plane wave propagation, including all of the reflections within the plasma layer. A solution in closed form was obtained, under small signal conditions, for the field at the h-th harmonic in the Fourier series. A discussion of the wave properties at the second harmonic frequency as a function of the d-c magnetic field strength, the electron density, the electron-neutral particle collision frequency, the field strength of the incident wave, and the thickness of the plasma layer is given. (auth)

10208 (NP-9777) SHOCK WAVES IN RADIATION-MAGNETOGASDYNAMICS. S. I. Pai and A. I. Speth (Maryland. Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Nov. 1960. 24p. Contract AF49(638)-401. (BN-223; AFOSR-38).

The general Rankine-Hugoniot relations for a normal shock wave in radiation-magnetogasdynamics were investigated. It was found that these relations differ considerably from those without radiation effects, particularly for the case that the gas is initially so hot that the radiation pressure is not negligible. For a given strength of the shock wave, the temperature jump across the shock with radiation effect is much smaller than that without radiation effect. Various limiting cases have been discussed. In certain cases the results may be expressed in terms of an effective ratio of specific heats γ_e and an effective gas pressure. A general method of solution by successive approximations is given. Some numerical results are obtained. (auth)

10209 (NP-9778) THE CONTAINMENT OF PINCHED DISCHARGE BY AN AXIAL MAGNETIC FIELD. [PART] I. R. K. Jaggi (Maryland. Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Dec. 1960. 15p. Contract AF18(600)-1315. (BN-221; AFOSR-47).

A mathematical investigation was made which estimates the influence of an imposed parallel magnetic field on particle loss to container walls. (W.L.H.)

10210 (NP-9782) STUDY OF THE CONFIGURATION OF A PLASMA IN AN AXIALLY SYMMETRIC MAGNETIC FIELD (thesis). Sylvan Katz (California. Univ., Los Angeles). Nov. 1959. 150p.

Two types of closed form analytic solutions were derived for the configuration of a low β, two-fluid, fully ionized plasma immersed in an externally applied axially symmetric magnetic field. For one type of solution, a specified form of heat flow found to be in agreement with the results of other investigators is present in the plasma. In such cases the solutions representing the plasma configuration are expressed in terms of the external magnetic-field structure and the boundary conditions imposed on the plasma. For the other type of solution, no constraint is imposed upon the form of the heat flow. These solutions are also expressible in terms of the external magnetic-field structures and the boundary conditions. However, for the second type of solution, the plasma density and the plasma perpendicular pressure need be specified as a priori throughout the system. (W.L.H.)

10211 (NP-9788) PERFORMANCE CHARACTERISTICS OF A VORTEX STABILIZED PLASMA GENERATOR USING ARGON. R. H. Clark, W. P. Dixon, D. L. McIntosh, W. A. Rinehart, and W. M. Van Camp (McDonnel Aircraft Corp., St. Louis). Feb. 1960. 93p.

The performance characteristics of a vortex stabilized plasma generator using argon as the working fluid and discharging directly to the atmosphere were investigated. Nozzle Stanton numbers decreased with increasing Reynolds numbers and were 1.5 to 6.0 times as large as those predicted for the turbulent flow of a gas in a circular tube. For a given nozzle and electrode spacing, the generation efficiency increased with increasing gas flow rate. The effect of swirl on the gas flow rate without energy addition was to decrease the flow rate from that predicted by adiabatic flow theory for a given value of the flow parameter $p_0A/\sqrt{T_0}$. For a given electrode spacing and nozzle size, the electrical conductance of the arc increased linearly with increasing stagnation temperature and the arc potential was proportional to the square root of the gas flow rate. (auth)

10212 (NYO-7739) RESEARCH IN PLASMA PHYSICS, SECOND ANNUAL PROGRESS REPORT, MAY 1, 1957–APRIL 30, 1958. Winston H. Bostick (Stevens Inst. of Tech., Hoboken, N. J.). Mar. 5, 1958. 7p. Contract AT(30-1)-1921.

The study of the mechanism of propulsion of plasma from button sources is under way. The effect of parameters such as wire size, spacing of wires, and peak current is being studied experimentally. Photographs with a Kerr cell show that two jets of plasma directed at one another can either attract or repel, depending upon the sign of the impact parameter. Design details of the betatron-condition-shaped one-turn coil to operate at 200,000 gauss were completed. Planning was begun for a theoretical and experimental program on microwave diagnostics of plasmas with particular emphasis on projected plasmoids. (W.L.H.)

10213 (RISÖ-20) DESCRIPTION OF AN EXPERIMENT WITH A MAGNETICALLY DRIVEN SHOCK. T. Hesselberg Jensen and V. O. Jensen (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). Nov. 1960. 20p.

An experiment, in which a magnetically driven plane shock is produced between two metal plates, is described. Velocities of 10 cm/μsec are obtained in hydrogen. The

electrical field strength applied is ~8 kv/cm, and the energy bank contains about 10 k joules. (auth)

10214 (TID-3557) CONTROLLED THERMONUCLEAR PROCESSES. A Literature Search. Raymond L. Scott and Sidney F. Lanier (Office of Technical Information Extension, AEC). November 1960. 109p.

A bibliography is presented on plasma physics and the theory, design, development, and experimentation related to controlled thermonuclear reactions. The references are from Nuclear Science Abstracts, December 1959, to December 1960. (709 references) (T.R.H.)

10215 (TID-11638) THE APPLICATION OF IGNITRONS AS SWITCHING DEVICES IN CONTROLLED FUSION RESEARCH. G. P. Boicourt and E. L. Kemp (Los Alamos Scientific Lab., N. Mex.). [nd]. 11p.

A description is given of the installation of a size A ignitron in the Perhapsatron. Typical operation of the ignitron is for a capacitor voltage of 15 kv; peak current of 12,000 amp with 85% voltage reversal, and a period of 50 μsec. A study was made of a ceramic-walled tube which had a titanium anode and a dielectric starter. A major change in tube design was the so-called double pantleg tube, which has a double concentric glass sleeve extending down from the glass anode seal. This tube showed an intermittent failure rate of 1 to 8%. (B.O.G.)

10216 (AEC-tr-4068) MAGNETOACOUSTIC RESONANCE IN PLASMA. A. P. Akhmatov, P. I. Blinov, V. F. Bolotin, A. V. Borodin, P. P. Gavrin, E. K. Zavoĭskiĭ, I. A. Kovan, M. N. Oganov, B. I. Patrushev, E. V. Piskarev, V. D. Rusanov, G. E. Smolkin, A. R. Striganov, D. A. Frank-Kamenetskiĭ, P. A. Cheremnykh, and R. V. Chikin. Translated from a Publication of the Order of Lenin Institute of Atomic Energy, Academy of Sciences U.S.S.R. Moscow, 1960. Zhur. Eksptl'. i Teoret. Fiz. 39: 536-44 (1960). 20p.

An experimental investigation of magnetoacoustic oscillations in cold plasma is described. It is shown that under definite conditions an intense penetration of the high-frequency electromagnetic field inside the plasma occurs, accompanied by resonant absorption of high-frequency energy. Results are described of the investigation of resonance at frequencies of 12.5 and 50 Mc by various experimental methods. A comparison is made between the results obtained and the conclusions of the theory. (auth)

10217 (AEC-tr-4281) DYNAMIC STABILIZATION OF A PLASMA LOOP. S. M. Osovets. Translated from a publication of the Institute of Atomic Energy, Academy of Sciences, USSR. Dec. 1960. 11p.

This paper was previously abstracted from the original language and appears in NSA Vol. 15, abstract No. 987

10218 RECENT ADVANCES IN ELECTRIC ARC PLASMA GENERATION TECHNOLOGY. Richard R. John and William L. Bade (Avco Research and Advanced Development Div., Wilmington, Mass.). ARS Journal, 31: 4-17 (Jan 1961).

A state-of-the-art review is presented with particular attention to arc-heated wind tunnels and space engines. The material is divided into sections on applications, design and operating characteristics, and factors affecting performance. The applications discussed are chemical synthesis, refractory processing, high-temperature research, reentry simulation, and space propulsion. The recent types of plasma generators nearly all have rotational symmetry with coaxial electrodes with an annular gap for the arc and through which the gas flows. The three principal configurations in use are cylindrical, toroidal, and constricted. The voltage-current characteristics, calibration procedures, operating limits, contamination, a-c operation, and r-f heating are also discussed. The factors affecting plasma generator performance are discussed as convective and radiative heat losses, electrode processes, arc-column behavior, and magnetic-field effects. (168 references.) (T.R.H.)

10219 EXPERIMENTAL RESULTS WITH A COLLINEAR ELECTRODE PLASMA ACCELERATOR AND A COMPARISON WITH ION ACCELERATORS. W. L. Starr and S. W. Kash (Lockheed Aircraft Corp., Sunnyvale, Calif.). ARS Journal, 31: 58-61(Jan. 1961).

A collinear electrode plasma accelerator using either plasma derived from an exploding wire or from electrode erosion has been in operation for some time. Maximum particle velocities approaching 10^7 cm/sec and impulses of 2×10^3 dyne·sec were achieved. Effective specific impulses, computed from measured impulse and propellant mass, greater than 2000 sec have been obtained for the exploding wire measurements. For certain conditions of operation, the efficiency is greater than 30%. Efficiencies of 50% or more should be possible. The practicality of deriving the plasma by electrode erosion is demonstrated, and effective specific impulses of about 6000 sec are indicated. (auth)

10220 REFLECTION OF A RING CURRENT BY A PLASMA. V. N. Tsytovich. ARS Journal, 31: 136-7(Jan. 1961).

An investigation was made of some questions of the dynamics of a collision between a ring current and a plane boundary formed by a plasma, the initial velocity of the ring current being in the nonrelativisitic range. It is shown that even a fairly tenuous plasma may serve as an excellent reflector of such ring currents. (T.R.H.)

10221 LINEAR APPROXIMATION OF VELOCITY IN THE CASE OF UNIDIMENSIONAL MOTION OF A PLASMA HAVING FINITE CONDUCTIVITY. L. B. Levitin and K. P. Stanyukovich (Moscow Government University, S.S.S.R.). Doklady Akad. Nauk S.S.S.R., 134: 300-3(Sept. 11, 1960). (In Russian)

An analysis is presented, in a new approximation, of the unidimensional motion of a plasma under the influence of a magnetic field at its boundary (a "magnetic piston"). The configuration is that encountered in an electromagnetic shock tube. The magneto-gasdynamic equations are written neglecting viscosity and thermal conductivity. It is assumed that the electrical conductivity is sufficiently great that displacement current and convection can also be ignored. The customary procedure in treating this problem is to construct approximate solutions in which the functional form of the plasma velocity is assumed in advance. The specific assumption made is that the velocity in the region between the magnetic piston and the shock-wave front is a linear function of the spatial coordinate where the (two) coefficients are arbitrary functions of time. The first step in solving the problem consists of determining the magnetic field in the plasma in terms of the arbitrary functions and the boundary conditions. The pressure and density functions are then found from the equation of continuity and the equation of motion. Finally, the shock-front balance conditions are used to determine implicitly the form of the assumed functions and the velocity of the shock front. (ITT)

10222 ON LONGITUDINAL MOTION IN A MAGNETIC FIELD. H. P. Greenspan (Massachusetts Inst. of Tech., Cambridge). J. Fluid Mech., 9: 455-64(1960). (AFOSR-TN-60-141).

An exact solution is presented of the equations and boundary conditions governing the steady longitudinal motion of a semi-infinite nonconducting plate in an oblique magnetic field. The discussion covers the distortion of the boundary layer, the structure of the induced electric and magnetic fields, the current-density distribution, and the behavior of the fields near the edge of the plate. (auth)

10223 ON A MOVING BOUNDARY PROBLEM. Sylvan Katz (Aeronutronic, Newport Beach, Calif.). J. Math. Phys., 2: 149-50(Jan.-Feb. 1961).

An exact analytic solution is obtained for a uniformly expanding, neutral, infinitely conducting plasma sphere in an external uniform and constant magnetic field. (auth)

10224 GENERAL STUDY OF THE RETURN TO EQUILIBRIUM OF A PARTICLE IN A PLASMA (FOKKER-PLANCK FORMALISM). J. Salmon (Faculté des Sciences, Caen, France). J. phys. radium, 21: 699-707(Oct. 1960). (In French)

The problem of the return to equilibrium of a particle in a plasma is examined, and the Fokker-Planck equation is completely explained. The possibility of interpreting the return of the test particle to Maxwellian distribution, using the development which is obtained, is studied. The validity limits of the Rosenbluth, MacDonald, and Judd approximation are examined. (auth)

10225 GAS-INSULATION OF A HOT PLASMA. Hannes Alfvén and Erik Smårs (Royal Institute of Technology, Stockholm, Sweden). Nature, 188: 801-2(Dec. 3, 1960).

A method is described for the separation of a plasma from the walls of a vessel with a magnetized gas at high pressure. The thermal conductivity variation with temperature is shown with four maxima, caused by: (1) dissociation, (2) ionization, (3) electron conductivity, and (4) ion conductivity. In comparison with a vacuum-insulated plasma, the gas-insulated device may have some advantage: (1) it is not subject to the same types of instabilities—but possibly to other types; (2) it should be easy to produce a clean plasma because the hot region is protected from wall dirt by a thick layer of gas at high pressure. Conditions are given for the attainment of critical powers of 24 and 600 kw cm^{-1} and maximum ion conductivity temperatures of 1.6×10^5 and 4×10^5 degrees. (E.O.G.)

10226 STABILITY OF A SLIGHTLY INHOMOGENEOUS PLASMA. Nicholas A. Krall and M. N. Rosenbluth (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 4: 163-72(Feb. 1961). (GA-1417).

Slightly inhomogeneous plasmas were studied to determine their stability against growing longitudinal electrostatic oscillations. The procedure was to expand Maxwell's equations and the collisionless Boltzmann equation about $\epsilon = 0$, corresponding to a uniform plasma, where the expansion parameter ϵ characterizes the particle density gradient. It was found that the shift in the eigenfrequency of the oscillation is of order ϵ^2, this shift is a real number to order ϵ^2 if the eigenfrequency for the corresponding uniform plasma, $\epsilon = 0$, is a real number. Transverse modes were also examined for some special directions of propagation, with similar results. It was observed that this expansion procedure would not reproduce instabilities associated with particle drifts. (auth)

10227 KIRCHOFF'S RADIATION LAW FOR PLASMAS WITH NON-MAXWELLIAN DISTRIBUTIONS. G. Bekefi, Jay L. Hirshfield, and Sanborn C. Brown (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 4: 173-6(Feb. 1961).

Calculations for interpreting microwave radiation measurements from plasmas with non-Maxwellian distributions of electron velocities are given for the radiation temperature in terms of the average electron energy. (auth)

10228 HYDROMAGNETIC AND PLASMA SCALING LAWS. A. Beiser (New York Univ., New York) and B. Raab. Phys. Fluids, 4: 177-81(Feb. 1961).

The Buckingham II theorem was applied to derive two sets of dimensionless parameters; one set for the quantities in the equations of Maxwell and Navier-Stokes, and the other containing the quantities involved in the Boltzmann equation. Ten independent dimensionless parameters were thus derived, which represent a complete set of scaling laws for phenomena describable by these equations and which contain among them the ordinary fluid-dynamic scaling parameters: the Mach and Reynolds numbers. (auth)

10229 PHYSICAL PRINCIPLES OF MAGNETOHYDRODYNAMIC POWER GENERATION. Richard J. Rosa (Avco-Everett Research Lab., Everett, Mass.). Phys. Fluids, 4: 182-94(Feb. 1961).

Some phenomena apt to be of importance in a magnetohydrodynamic power generator are discussed. Particular attention is given to the effects of seeding on gas conductivity and to the Hall effect as it appears in nonuniform gases of finite extent. An experimental 10-kw magnetohydrodynamic generator is described. An arc wind tunnel or "plasma jet" was used as a convenient laboratory "furnace" to heat the working fluid. The generator's performance, including some observed Hall effects, is presented and discussed. (auth)

10230 ON THE ANGULAR DISTRIBUTION OF CYCLOTRON RADIATION FROM A HOT PLASMA. B. A. Trubnikov (Inst. of Atomic Energy, Academy of Sciences, Moscow). Phys. Fluids, 4: 195-8(Feb. 1961).

The formula of Drummond and Rosenbluth for the angular dependence of the absorption coefficient of cyclotron radiation from a hot plasma is too crude, and hence the numerical estimates based on this formula for the total radiation from a plasma layer were less valid than previous results. (auth)

10231 CONFIGURATION OF A PLASMA IN AN AXIALLY SYMMETRIC MAGNETIC FIELD. Sylvan Katz (Univ. of California, Los Angeles). Phys. Fluids, 4: 204-9(Feb. 1961).

Closed-form analytic solutions were obtained for the static configuration of a fully ionized low-β-density adiabatic plasma immersed in an externally applied axially symmetric magnetic field. There was first introduced a special orthogonal curvilinear coordinate system, one of whose coordinate curves coincided with the externally applied magnetic field. Then, by performing a perturbation expansion for a low-β adiabatic plasma, a system of zero-order equations was obtained. Although this system of equations is incomplete, in that there are more unknowns than equations serving for their determination, a determinate integrable system of equations was obtained by specifying that the diagonal elements of the divergence of the zero-order heat-flux tensor vanish. This system of equations was integrated to yield analytic results dependent of the boundary conditions imposed upon the plasma. Finally, if a trapping criterion is to be satisfied, the boundary conditions imposed upon the plasma must satisfy certain inequalities. (auth)

10232 LOW-DENSITY PLASMA FLOW AT A MAGNETIC BARRIER. M. A. Gillec (Lockheed Aircraft Corp., Sunnyvale, Calif.). Phys. Fluids, 4: 210-14(Feb. 1961).

The encounter of a low-density stream of plasma with a barrier in an otherwise uniform axial magnetic field is treated theoretically on the basis of particle dynamics. Conditions are considered for which the magnetic moments that result from the transverse velocities of the particles are adiabatically invariant within the barrier region. At the barrier there is an increase of magnetic field, caused by external currents, and an increase in the electric potential ϕ, caused by charge separation in the plasma. Within the barrier the electric potential brings about an exchange of energy $e\phi$ between ions that carry the kinetic energy of the stream and electrons so that both may penetrate in equal number. The penetration of the barrier, the force on it, and the change of electric potential in it are given in terms of the ratio of barrier to guiding-field, stream velocity, and the temperatures of the ions and electrons. A comparison was made with results which were obtained for an encounter in which the barrier rises so rapidly that the moment of the ions is not adiabatically invariant and for which the Rosenbluth-Garwin sheath model was employed. This model is appropriate to cases in which a rapidly varying current flows on the surface of the plasma (skin effect), as in the pinch effect. Much greater penetration takes place with the slowly varying magnetic field which may be encountered when the field is produced by current-carrying conductors external to the plasma. (auth)

10233 DIFFUSION OF A COLD CESIUM PLASMA ACROSS A MAGNETIC FIELD. N. D'Angelo and N. Rynn (Princeton Univ., N. J.). Phys. Fluids, 4: 275-6(Feb. 1961).

The diffusion of a highly ionized low-temperature cesium plasma across a magnetic field was investigated. The radial diffusion coefficient ($D_\perp$) across the field is $D_\perp = A\,n$, where n = the plasma density and $A = 2\eta k\,T/B^2$ (η = the resistivity of the plasma, k = the Boltzmann constant, T = the ion and electron temperature, and B = the magnetic field). The plasma seemed to show a $1/B^2$ dependence of $D_\perp$ with magnetic field. The results for the absolute magnitude of $D_\perp$ agreed with classical diffusion theory to within an order of magnitude. (M.C.G.)

10234 COMMENTS ON SYNCHROTRON RADIATION. W. E. Drummond and M. N. Rosenbluth (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 4: 277-8(Feb. 1961).

An approximate form obtained for the angular distribution of synchrotron radiation was found to agree with that obtained by Trubnikov. Application to the thermonuclear problem is being investigated by a numerical evaluation of the contour integrals of the type given by Trubnikov and a geometrical integration over the various directions and frequencies of emission for plasma slabs and cylinders. The results for absorption coefficient are given for a typical case as a function of angle. (M.C.G.)

10235 COMMENT ON THE ANGULAR DEPENDENCE OF PLASMA SYNCHROTRON EMISSION. David B. Beard and John C. Baker (Univ. of California, Davis). Phys. Fluids, 4: 278(Feb. 1961).

A numerical study was made of plasma emission from a plasma with a two-dimensional velocity distribution limited to directions perpendicular to the magnetic field. It was found that the Drummond-Rosenbluth approximation is extremely good for an electron gas whose velocity vector is essentially perpendicular to the confining magnetic field. (M.C.G.)

10236 ELECTROMAGNETIC INTERACTION OF A BEAM OF CHARGED PARTICLES WITH PLASMA. Jacob Neufeld and P. H. Doyle (Oak Ridge National Lab., Tenn.). Phys. Rev., 121: 654-8(Feb. 1, 1961).

The plasma-beam instability was studied by Akhiezer and Fainberg under the assumption that $\theta = 0$, where θ is the angle formed by the direction of the beam and the direction of the growing wave resulting from the instability. Under these conditions the interaction is electrostatic, i.e., the wave is longitudinal. The assumption was generalized so as to include the case of $\theta \neq 0$ and the effect of electromagnetic interaction. For $\omega \sim \omega_1$, where ω_1 is the Langmuir frequency of the plasma, the interaction is electrostatic for all values of θ and the resulting instability which produces a longitudinal wave increases exponentially in accordance with the term $\exp(3\sqrt{3}\omega_0^{\frac{2}{3}}kv_0 \cos\theta/8)^{\frac{1}{3}}$ (where ω_0 is the Langmuir frequency of the beam). For a frequency range below ω_1 the instability is less pronounced. However, this instability is significant, since the interaction is electromagnetic and the "growing wave" resulting from this interaction is characterized by an electric vector having both transverse and longitudinal components. In investigating these instabilities, an assumption was made that the density of the incident beam is small and the results cover all values of θ except those in the immediate neighborhood of $\pi/2$. For θ in the neighborhood of $\pi/2$ the assumption is more general and the results apply to any density of the beam. (auth)

10237 HIGH-FREQUENCY POTENTIAL WELL FOR DENSE PLASMAS. Albert J. Hatch (Argonne National Lab., Ill.). Phys. Rev. Letters, 6: 53-5(Jan. 15, 1961).

A newly recognized absolute potential well which theoretically appears to be capable of containing dense plasmas is described. The interior volume of plasma was considered to be field-free. It was assumed that the plasma could be represented by a small rigid neutral conducting sphere. The existence of the wells indicates the possibility of phenomena involving the interaction of plasmas with electromagnetic fields. (M.C.G.)

10238 NONLINEAR INTERACTION OF AN ELECTROMAGNETIC WAVE WITH A PLASMA LAYER IN THE PRESENCE OF A STATIC MAGNETIC FIELD. I. THEORY OF HARMONIC GENERATION. R. F. Whitmer and E. B. Barrett (General Telephone and Electronics Labs., Palo Alto, Calif.). Phys. Rev., 121: 661-8(Feb. 1, 1961).

The theory of electromagnetic wave propagation through an anisotropic ionized layer, including the effects of the nonlinear terms in the Boltzmann transport equation, is presented. The method of solution of the nonlinear equations involves an expansion of all of the dependent variables in a Fourier series in time. The differential equations describing wave propagation were solved, for each frequency in the series, for plane wave propagation, including all of the reflections within the plasma layer. A solution in closed form was obtained, under small signal conditions, for the field at the nth harmonic in the Fourier series. A discussion of the properties of the wave at the second harmonic frequency as a function of the d-c magnetic field strength, the electron density, the electron-neutral particle collision frequency, the field strength of the incident wave, and the thickness of the plasma layer is given. (auth)

10239 DETONATION-GENERATED PLASMAS. A. Bauer, M. A. Cook, and R. T. Keyes (Univ. of Utah, Salt Lake City). Proc. Roy. Soc. (London) A, 259: 508-17 (Jan. 24, 1961).

Photographic sequences at the rate of a million exposures a second of the brilliantly luminous, highly ionized gas clouds or detonation-generated plasmas emitted from free surfaces of detonating explosives, showing interesting com-

pressional, extrusion and expansion effects are presented and discussed. Means of separating and differentiating the shock waves and plasmas associated with the detonation of condensed explosives are illustrated. Examples of plasma explosions are presented illustrating the particular metastable character of these plasmas. Measurements of the velocity-conductivity-density relations in the plasmas are presented and their resemblance to metals discussed. (auth)

10240 THE EFFECT OF THE ORIENTATIONS OF ELECTRIC AND MAGNETIC FIELDS ON THE ELECTRON MEAN ENERGY AND DRIFT VELOCITY IN A PARTIALLY IONIZED GAS. Ching-Sheng Wu (California Inst. of Tech., Pasadena). Proc. Roy. Soc. (London) A, 259: 518-30 (Jan. 24, 1961).

The present investigation attempts to analyze the influence of the orientations of the imposed magnetic and electric fields on the mean electron energy and drift velocity. For this purpose, the electron velocity distribution function relating to the presence of the external fields with arbitrary orientations is first studied. The analysis is based on the Lorentz approximation, and it is assumed that the electron velocity distribution is determined essentially by the electron-atom collisions. The mean electron energy is discussed for two different cases: constant mean free path and constant collision time. In the case of constant collision time, the drift velocity, as well as the electron current density, is calculated. The Hall conductivity is expressed in a general form that depends upon the direction of the magnetic field with respect to the electrical field. Besides this an additional component of the current is theoretically observed; in general, it vanishes if the magnetic field is either parallel or perpendicular to the electric field. (auth)

10241 MAGNETO-FLUID DYNAMICS. Proceedings of a Symposium held in Williamsburg, Va. and Washington, D. C., January 1960. Revs. Modern Phys., 32: 693-1033 (Oct. 1960).

The main purpose of the symposium was to bring out new information in areas which seem to need clarification and where direct contact between investigators would have the greatest value. Separate abstracts were prepared for each of 48 papers. (B.O.G.)

10242 PROBLEMS IN MAGNETO-FLUID DYNAMICS. Lyman Spitzer, Jr. (Princeton Univ., Princeton, N. J.). Revs. Modern Phys., 32: 696-700 (Oct. 1960).

A survey is given of the problems encountered when investigating a conducting liquid or gas moving in a magnetic field. It is considered that magneto-fluid dynamics include all problems which may arise when a gas or liquid is interacting with a magnetic field. The various problems are grouped together according to the magnitude of the mean macroscopic velocity v, defined as the mean velocity of all particles in a small volume element at a particular time. The survey includes discussions on: the basic processes of the field; the situation in which v vanishes and a magnetostatic equilibrium is present; problems of infinitesimal v, including both waves and instabilities; problems of finite v for a steady state system and the situation where time derivatives are not zero; and the most important magnetofluids found in nature and in the laboratory. (39 references). (B.O.G.)

10243 SOME REMARKS ABOUT FLOW PAST BODIES. W. R. Sears (Cornell Univ., Ithaca, N. Y.). Revs. Modern Phys., 32: 701-5 (Oct. 1960).

Some remarks are made on steady flow past solid bodies in the presence of external magnetic fields. Certain common features seem to be recognizable in the results of a number of studies on this class of problems. These are features which appear to distinguish flows of low conductivity from those of high conductivity, i.e., flows of low magnetic Reynolds number R_M from those of high R_M. There are unmistakable analogies between the influences of the magnetic and the actual Reynolds numbers in this class. (B.O.G.)

10244 MAGNETO-FLUID DYNAMIC SHOCK WAVES. R. Lüst (Max-Planck-Institut für Physik und Astrophysik, Munich, Ger.). Revs. Modern Phys., 32: 706-9 (Oct. 1960).

A discussion is given on the structure of hydromagnetic shock waves where the collision frequency is very low compared to the gyrofrequency of the ions or electrons. Three problems are discussed: the general properties of the shock waves and the influence of the magnetic field; the thickness of the shock wave; and which of the various kinds of shock waves can occur and which do develop, if an initial perturbation is given. (B.O.G.)

10245 COLLISION BETWEEN A NONIONIZED GAS AND A MAGNETIZED PLASMA. H. Alfvén (Royal Inst. of Tech. Stockholm, Sweden). Revs. Modern Phys., 32: 710-13 (Oct. 1960).

The case when a low-density plasma is hit by a continuous stream of nonionized gas of the same chemical composition is considered. It is assumed that the plasma is fixed by a magnetic field and the electric field is zero, and the initial temperatures of the gas and plasma are zero. A summary is given of the experimental results found by Block and Fahleson on the collision processes. A theory is developed for the ionization of the gas atoms by the plasma ions. (B.O.G.)

10246 LONG-RANGE FORCES AND THE DIFFUSION COEFFICIENTS OF A PLASMA. W. B. Thompson and J. Hubbard (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Revs. Modern Phys., 32: 714-18 (Oct. 1960).

The nature of the effective interaction between particles when correlation effects are taken into account is discussed. It has been observed that the encounters between the particles are not binary, since there are many particles inside the screening sphere set up by the electric field of the particles. The dielectric behavior of a plasma is discussed. The field of a test particle is discussed and the validity of the screened Coulomb approximation is assessed. The diffusion coefficients are calculated in terms of the fluctuating electric microfield produced by the partially correlated motion of the electrons. The energy spectrum of the fluctuating microfield is calculated. An evaluation was made of the diffusion coefficients. (B.O.G.)

10247 TRANSPORT EQUATION OF A PLASMA. R. Balescu (Université Libre, Brussels, Belgium). Revs. Modern Phys., 32: 719-21 (Oct. 1960).

It is shown that the many-body problem in plasmas can be handled explicitly. An equation describing the collective effects of the problem is derived. For simplicity, a one-component gas is considered in a continuous neutralizing background. The tool for handling the problem is provided by the general theory of irreversible processes in gases. The equation derived describes the interaction of electrons which are "dressed" by a polarization cloud. The polarization cloud differs from the Debye cloud. (B.O.G.)

10248 IRREVERSIBLE PROCESSES IN PLASMAS IN A STRONG MAGNETIC FIELD. Taro Kihara and Yukio Midzuno (Univ. of Tokyo, Japan). Revs. Modern Phys., 32: 722-30 (Oct. 1960).

A discussion is given of the irreversible processes in plasmas in a strong magnetic field. The processes can be classified with regard to the tensor rank of the irreversible flow. Considerations are given for the relaxation between ion and electron temperatures where the flow is a scalar, and for electric and thermal conductions where the flows are vectors. The theory of irreversible processes may be considered from the phenomenological (macroscopic) or molecular (microscopic) point of view. The phenomenological theory is an application of the thermodynamic properties of irreversible processes. The characteristic features of the phenomenological coefficients in linear relations are discussed for the processes in strong magnetic fields. The microscopic theory is an application of the force-correlation formalism to a gaseous plasma. (B.O.G.)

10249 DYNAMICAL EQUATIONS AND TRANSPORT RELATIONSHIPS FOR A THERMAL PLASMA. R. Herdan and B. S. Liley (Associated Electrical Industries, Ltd., Aldermaston, Berks, Eng.). Revs. Modern Phys., 32: 731-41(Oct. 1960).

Assuming that the behavior of a plasma can be adequately described in terms of binary collisions, the results can be applied directly to a thermal plasma in a magnetic field. Unfortunately, the relevant equations are extremely complicated, and for this reason their value is somewhat questionable. The equations are presented in summary form, emphasizing the difference between these and those of magnetohydrodynamics. The basis of the general theory for a multicomponent gas mixture is outlined. Dynamical equations of change for a finite number of macroscopic variables are generated and then closed by using a 13-moment approximation for the velocity distribution function. The equations derived in this manner for a binary plasma can be used to generate transport relations by a method of successive approximations. The significance of relaxation and other characteristic times is discussed. The validity of the 13-moment approximation and its relation to other types of approximations are discussed. (B.O.G.)

10250 MOTION OF A CHARGED PARTICLE IN A SLOWLY INCREASING MAGNETIC FIELD. L. J. F. Broer (Technische Hogeschool, Delft, Netherlands). Revs. Modern Phys., 32: 742-3(Oct. 1960).

Considerations are given for a charged particle moving in a plane under the influence of a homogeneous magnetic field $B = \omega(m/e)$ perpendicular to the plane of motion. Approximate solutions, valid for a short interval, for fast and slow solutions can be developed by substituting $\underline{u} = \underline{a}\exp(-i\int f dt)$ in the equation of motion, $d^2u/dt^2 + i\omega du/dt + (i/2)d\omega/dt \cdot u = 0$, considering both $\underline{a}$ and $\underline{f}$ to be real slowly varying functions of $\underline{t}$. The motion equation can be reduced to the wave equation by letting the frame of reference rotate with half the Larmor frequency. Fast and slow solutions now correspond to wave solutions of the equation, traveling in forward and backward directions. (B.O.G.)

10251 HYDROMAGNETIC EQUILIBRIUM EXPERIMENTS WITH LIQUID AND SOLID SODIUM. S. A. Colgate, H. P. Furth, and F. O. Halliday (California. Univ., Livermore. Lawrence Radiation Lab.). Revs. Modern Phys., 32: 744-7(Oct. 1960). (UCRL-5752)

A liquid metal in a very rapidly oscillating magnetic field behaves essentially like a fluid of infinite conductivity in a static magnetic field. An experiment was conducted which consisted of passing an oscillating current along a vertical rod into a pool of oil and liquid sodium. The oscillating magnetic field B_θ generated about the rod creates an outward magnetic pressure, which forms a funnel-shaped depression in the surrounding sodium. The sodium was frozen while in a state of hydromagnetic equilibrium, the rod and oil were removed, and sealing wax castings were made of the depression. Comparison is made of a sectioned casting with a theoretical curve derived from $\langle B_\theta^2/8\pi\rangle = I^2/200\pi r^2 = g(\rho_{Na}-\rho_{Oil})(z-z_0)$, where I is the rms current in amperes and the surface of the sodium is at $z = z_0$, ρ is the fluid mass density, g is the acceleration of gravity, and z is the depth of the sodium. It is shown that theory and experiment agree quite well as soon as a modest depth is attained. Instability growth was demonstrated as possible at the magnetic energy densities used in the experiment by applying an oscillating field in intermittent bursts using a relaxation oscillator. Near $z = z_0$, where the magnetic pressure is weak, the instabilities are largely inhibited, but deeper in the depression instabilities of millimeter wavelength grow readily. Experiments with a solid sodium billet proved successful in demonstrating the short-wave Kruskal-Schwarzchild instabilities expected during the inward acceleration phase and the basic long-wave instability expected to develop in the equilibrium state. (B.O.G.)

10252 MAGNETIC COMPRESSION OF PLASMAS. Alan C. Kolb (U. S. Naval Research Lab., Washington, D. C.). Revs. Modern Phys., 32: 748-57(Oct. 1960).

Calculations are made for the additional heating that may be expected from the adiabatic compression of a shock-preheated plasma by a slowly rising axial magnetic field. This is done by considering the compression problem in the limit of high electrical conductivity and distinguishing between the loss mechanisms for rarefied and dense plasmas in the magnetic-mirror geometry. This model may be expected to describe the gross features of the discharge because the main source of particle loss is out the ends rather than across the field lines, and because the compressional heating is much larger than the joule heating at high temperatures. The modifications to the usual adiabatic equations caused by end losses and finite $\beta = 8\pi nkT/B^2$; $0 < \beta < 1$, result in that scaling laws can be obtained for use in experiment design, and to estimate more precisely plasma densities and temperatures from magnetic-compression data. It was found that the end losses drastically influence the state and volume of the plasma. The discussion delineates the region where particle losses lead to an additional heating of the confined plasma, and distinguishes between the confinement of low- and high-density plasmas in a magnetic-mirror device. Some experimental difficulties and limitations of the theory are discussed. (B.O.G.)

10253 SOME STUDIES OF FREE-SURFACE MERCURY MAGNETOHYDRODYNAMICS. R. A. Alpher, H. Hurwitz, Jr., R. H. Johnson, and D. R. White (General Electric Research Lab., Schenectady, N. Y.). Revs. Modern Phys., 32: 758-69(Oct. 1960).

The investigations had their origin in a suggestion to modify a water table as used to study the conventional hydraulic analogy by employing a conducting fluid flowing through a transverse magnetic field. A device using mercury was constructed to consider the possibility of a magnetohydraulic analogy. In the course of the studies, considerations were made for shallow-liquid magnetohydrodynamic flows, surface wave motions, and rotating flows. The work reported shows that the free-surface mercury channel has pedagogical value in understanding flows in which the magnetic Reynolds number is low and the dimensionless parameter, $N = (L/u)/\tau_0$, is of order unity. The possibility of obtaining semiquantitative data by using the channel as a magnetohydraulic analogy was established. While the principal application of the analogy may well be

to simulation of closed channel flows at low Reynolds numbers, there are undoubtedly special geometries for which the channel may provide useful insight into flow around bodies in the presence of magnetic fields. Appendixes are included on the wave equation for irrotational flow and vortex decay. (B.O.G.)

10254 EXPERIMENTS ON THE PASSAGE OF A SHOCK WAVE THROUGH A MAGNETIC FIELD. K. Dolder and R. Hide (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Revs. Modern Phys., 32: 770-9(Oct. 1960).

An investigation was made of the over-all conditions required for hydromagnetic interactions to occur between the rapidly moving portion of gas behind a strong shock in argon produced in a combustion-driven shock tube and the magnetic field of a short coil wound symmetrically around the tube. The general design considerations are given in which it was necessary to choose a geometry such that the emf caused by motional induction was not offset by a mere separation of charge, because if this occurs, the current flow ceases after a very short interval. Photographic observations were made of the shock waves by focusing a camera on the glass observation section of the shock tube, darkening the laboratory, and opening the camera shutter. Electromagnetic measurements were made to determine the density of the currents circulating in the plasma by using short pickup coils wound around the shock tube downstream from the magnetic coil at 3-cm intervals, then studying the waveforms of the induced emf's registered on oscilloscopes. Although the Lundquist number, Lu, was used as a working parameter, according to theory the interpretation of the results in terms of Lu can only be expected to be unambiguous when the magnetic Reynolds number, R_M, is large. When R_M is small the inducing field is hardly modified by the motion and then it is a straightforward matter to compare directly the inertial term with the $j \times B$ term in the equation of motion. (B.O.G.)

10255 SOME REMARKS ON ELECTRIC-DISCHARGE SHOCK-TUBE DIAGNOSTICS. Daniel Bershader (Lockheed Aircraft Corp., Calif., and Stanford Univ., Calif.). Revs. Modern Phys., 32: 780-4(Oct. 1960).

An investigation was made to determine whether there is a basic version of discharge tube which can serve to produce a quasi-uniform block of plasma. Operating conditions are described for a diaphragm type device with a Mach-25 shock proceeding into room-temperature argon at 1-mm pressure. The basic difference between the diaphragm type tube and the discharge type tube is that the latter makes use of a current flow as part of the energy addition process, which permits magnetic forces to aid in the acceleration of the gas. No simple conclusions can be drawn from previous results, but the results may be related to a basic requirement for a general-purpose electric-discharge shock tube, namely, the uniform-flow regime behind the advancing shock. Possible mechanisms in the rather constant wave and flow speeds are: energy-transfer time, vaporization of material in the electrode region, and electrode geometry. The uniformity of the plasma behind the shock is limited in any strict sense but may be adequate for the order of microseconds for aerodynamic and other applications. The use of a maintained piston-like drive all along the tube may be superior to controlled energy feed-in. (B.O.G.)

10256 TRANSITION FROM LAMINAR TO TURBULENT FLOW IN MAGNETO-FLUID MECHANIC CHANNELS. Paul S. Lykoudis (Purdue Univ., Lafayette, Ind.). Revs. Modern Phys., 32: 796-8 (Oct. 1960).

A theoretical criterion is established for the transition from laminar flow to turbulent flow in the case of channel flow when a magnetic field is acting perpendicularly to the flow. In the course of the calculations, the correct nondimensional parameters upon which the problem depends are presented and the structure of the turbulent boundary is discussed. The theoretical results are compared with available experimental results. (B.O.G.)

10257 HYDROMAGNETIC FLOW DUE TO AN OSCILLATING PLANE. R. Hide and P. H. Roberts (King's College (Univ. of Durham), Eng.). Revs. Modern Phys., 32: 799-806 (Oct. 1960).

A review is given of Stokes' problem concerning the effect of viscosity in modifying the motion of a fluid in contact with vibrating solids. A suggestion was made as to the possibility of measuring the effect of a magnetic field on the propagation of sound in a tube containing mercury. The obvious extension of Stokes' problem was to the case of a conducting fluid in the presence of an impressed uniform magnetic field of strength B_0 in the z direction. The hydromagnetic flow set up by the plane is governed by the equations of hydrodynamics and continuity, Maxwell's equations (neglecting displacement currents), and Ohm's law for a moving conductor. The boundary conditions necessary to determine the unique solution of these equations are outlined. A discussion is given of a number of limiting cases to the formal solution to the flow problem. The limitations are for low, moderate, and high conductivity ($\beta \gg 1$, $\beta = 1$, $\beta \ll 1$); in each case the effects of strong and weak magnetic fields are considered. Considerations are given for the rotating and nonrotating states of flow. (B.O.G.)

10258 ENERGY SPECTRA IN MAGNETO-FLUID DYNAMIC TURBULENCE. T. Tatsumi (Univ. of Kyoto, Japan). Revs. Modern Phys., 32: 807-12 (Oct. 1960).

The theory of ordinary turbulence based on the assumption of zero fourth-order cumulants was extended to magneto-fluid dynamic turbulence. Fundamental equations for determining the kinetic and magnetic energy spectra were derived and a calculation was made of the energy spectra decay from their initial forms of a single-line type. Some universal aspects of turbulence were investigated on this ground. The steady form of the energy spectrum for infinitely large Reynolds numbers was derived for the non-magnetic case. Possible forms of the steady spectrum are suggested for the magneto-fluid dynamic case, and some discussion is given on the possibility of the "turbulent dynamo." (B.O.G.)

10259 STABILITY OF A HOLLOW MERCURY JET. B. Lehnert and G. Sjögren (Royal Inst. of Tech., Stockholm, Sweden). Revs. Modern Phys., 32: 813-14 (Oct. 1960).

The possibility of trapping a plasma in a magnetic field generated by a ring-shaped solid conductor was investigated using a hollow mercury jet as a liquid-conductor model. The jet was formed around a glass-tube sheathed copper rod. It was found that if a sufficiently large current I_0 is sent through the central rod in the same direction as the current I in the jet, there is no sign of instability. The transition between stability and instability becomes sharper for strong currents and large electrodynamic forces than for weak currents. The transition for currents of 200 to 400 amp seems to occur at $I_0 = 1.37$ I. It is not possible to draw conclusions about the stability of a highly ionized plasma from the present results. This is because mercury has a comparatively low electric conductivity and the situation is very far from that of frozen field lines. (B.O.G.)

10260 TWO-DIMENSIONAL BOUNDARY LAYERS AND JETS IN MAGNETO-FLUID DYNAMICS. Günther Jungclaus

(Deutsche Versuchsanstalt für Luftfahrt e.V., Freiburg i.Br., Ger.). Revs. Modern Phys., 32: 823-27 (Oct. 1960).

The main assumptions and results are given for an investigation of two-dimensional incompressible laminar boundary layers in flows of electrically conducting fluids under the influence of a magnetic field having a direction coincident with the plane of flow. These assumptions and results are extended to the case of similar solutions for laminar jets. It is shown that the equation derived by Pai for jet flow into a fluid at rest has no solution. A generalization of Pai's transformation leads to a class of solutions which can be shown to contain all the possible similar solutions for that case. Two classes of solutions are given for jet flow into a moving fluid with pressure gradient. (B.O.G.)

10261 SOME MAGNETO-FLUID DYNAMIC EFFECTS IN A FINITELY CONDUCTING MEDIUM. V. N. Zhigulev (N. E. Zhukovskii Central Aerodynamic Inst., Moscow, U.S.S.R.). Revs. Modern Phys., 32: 828-30 (Oct. 1960).

The cases of motion which occur in real media possessing finite conductivity are discussed. The cases in magneto-fluid dynamics greatly resemble those in hydromechanics, where reference should be given to the theory of viscous fluids for treating and choosing a solution obtainable within the limits of the theory of a perfect fluid. The main features of the interactions between the outside magnetic field and the flow of a conducting gas are considered. Magnetic boundary layers of the first and second kind are illustrated. The main property of the boundary layers is the constancy of the value, $p + (H^2/8\pi)$, across the layer $(\partial p_m/\partial y = 0)$. Since the magnetic field tends to press-off the flow of a conducting gas, the gas in turn tends to oust the magnetic field, thus leading to the effect of screening. If the screening layer is a magnetic boundary layer of the second kind, the screening leads to the compression of a discharge channel in a gas. This effect has been analyzed. (B.O.G.)

10262 REDUCIBLE PROBLEMS IN MAGNETO-FLUID DYNAMIC STEADY FLOWS. Harold Grad (New York Univ., New York). Revs. Modern Phys., 32: 830-47 (Oct. 1960).

Some reducible fluid-magnetic boundary-value problems are developed in order to map out solvable mathematical structures and analyze the similarities and contrasts with ordinary fluid dynamics. This analysis of reducible flows serves to separate large classes of fluid-magnetic problems which are relatively accessible using fluid-dynamical techniques which may require the development of significantly new techniques in order to handle boundary-value problems. An analog is given which allows the application of a large part of the literature of inviscid fluid dynamics to a part of magneto-fluid dynamics. Another reduction to a system with essentially one characteristic cone is given by the parallel flows (fluid velocity and magnetic field locally parallel). This constraint is compatible in the sense that it does not restrict the solution to a few isolated flows but allows the imposition of a class of arbitrary boundary conditions. The reduction for the fluid-magnetic equations was carried out for two-dimensional steady flow, treating only the linear problem of perturbations about a uniform magnetic field B_0, arbitrarily oriented and a uniform flow, u_0. The results are applied to the flow around a thin airfoil. The flow about a three-dimensional plane lamina with an arbitrary cross section, described in terms of the given normal component of velocity as a boundary condition, was investigated. (B.O.G.)

10263 SOME EXACT SOLUTIONS IN LINEARIZED MAGNETOAERODYNAMICS FOR ARBITRARY MAGNETIC REYNOLDS NUMBERS. E. L. Resler, Jr. and J. E. McCune (Cornell Univ., Ithaca, N. Y.). Revs. Modern Phys., 32: 848-54 (Oct. 1960).

Maxwell's equations and Ohm's law combined with the equations governing the motion of compressible inviscid fluids with scalar electrical conductivity are sufficient to describe many of the phenomena in magnetoaerodynamics. Simplifications have been made by treating small perturbations to some initial state and linearizing the equations about that initial state. A general treatment of the linearized equations is presented and special solutions for the flow past an insulating sinusoidal wall with various magnetic field geometries are given. Arbitrary values of the conductivity and compressibility are included, and some numerical estimates of magnetoaerodynamic effects are made. (B.O.G.)

10264 MOTION OF BODIES THROUGH CONDUCTING FLUIDS. K. Stewartson (Univ. of Durham, Eng.). Revs. Modern Phys., 32: 855-9 (Oct. 1960).

The determination of the motion in a fluid of electrical conductivity σ and kinematic viscosity ν by the joint action of an external magnetic field and a solid body moving relative to it is of interest. In order to obtain useful results from this problem, it is necessary to consider simple limiting conditions, such as: the fluid is a continuum and incompressible, the current may be described by Ohm's law, and the effect of the flow of charge and of displacement current may be neglected. Five limiting conditions concerning the steady motion of a perfectly conducting inviscid fluid past a fixed body in a strong magnetic field H are given: (1) $\sigma \to \infty$, (2) $\nu \to 0$, (3) $t \to \infty$, (4) A/a = (scale of magnetic field/scale of body) $\to \infty$, and (5) $V/U = [|H|/(4\pi\rho)^{1/2}]/U$ = [Alfvén velocity/fluid velocity] $\to \infty$. A discussion is given concerning the dependence of flow past a body in a strong magnetic field on the quantities: $\nu\sigma$, A/Vt, and t/σ as the limits are taken. (B.O.G.)

10265 MAGNETOHYDRODYNAMIC WAKES IN A VISCOUS CONDUCTING FLUID. Hidenori Hasimoto (Johns Hopkins Univ., Baltimore, Md.). Revs. Modern Phys., 32: 860-6 (Oct. 1960).

The steady two-dimensional flow of an incompressible fluid with finite electric conductivity is discussed. It is assumed that the magnetic field and velocity vectors are in the plane of flow and each reaches a constant value at infinity. Formulas were obtained for the cases where: the undisturbed velocity and magnetic field are parallel; the magnetic Prandtl number, $\lambda = \nu/\kappa$, is unity, where ν is the kinematic viscosity, and κ is the magnetic viscosity of the fluid; and the Stokes flow in which the undisturbed velocity U is very small compared to the Alfvén-wave propagation speed a. The formation of two wakes, instead of one, is observed, and, in general, the points are in different directions. It was found that the upstream wake appearing for $U < a$ is dominant in the total mass flux and the total magnetic flux along the wake compared with the downstream wake, except where $a/U \gg \lambda^{\pm 1/2}$, in which both wakes have equal strength. The drag and lift for an insulating circular cylinder are determined. (B.O.G.)

10266 SOME REMARKS ON HYDROMAGNETIC WAVES FOR FINITE CONDUCTIVITY. E. L. Resler, Jr. (Cornell Univ., Ithaca, N. Y.). Revs. Modern Phys., 32: 866-7 (Oct. 1960).

A discussion is given of the form which a Friedrichs diagram might take for hydromagnetic waves when the conductivity of the fluid is finite. The discussion is restricted to waves where the currents associated with the wave are perpendicular to the plane of the magnetic field and the wave normal. First quadrant diagrams are given for v_p/α as a

function of φ for various values of σ, for the cases were $a_\infty = \alpha$ and $a_\infty = \sqrt{2\alpha}$, where v_p is the phase velocity, α is the Alfvén speed, φ is the angle between the wave front direction norm and the magnetic field direction, a_∞ is the ordinary sound speed, and σ is the conductivity. (B.O.G.)

10267 MOTION OF A COMPLETELY IONIZED GAS ACROSS A MAGNETIC FIELD IN THE PRESENCE OF AN ELECTRIC FORCE. J. M. Burgers (Univ. of Maryland, College Park). Revs. Modern Phys., 32: 868-80 (Oct. 1960).

Considerations have been developed concerning whether a shock can appear in a completely ionized plasma subjected to a magnetic field, if the density and temperature are such that the randomizing effect of collisions can be omitted in the domain of transmission. It is assumed that the field, when described with reference to a coordinate system in which the shock is at rest, is independent of the time and is a function of the coordinate x (or x_1). It is supposed that there is a uniform state of flow with constant velocity U_0 (in the x_1 direction) for both positive ions and electrons in the domain $x < 0$. The investigation was conducted for the relations between change of motion and changes of pressure, magnetic and electric fields, including the appearance of a component E_1 of the electric field. The treatment is based upon the flow equations that can be derived from a Boltzmann equation, in which the right-hand side has been replaced by zero. (B.O.G.)

10268 ON THE THEORY OF PROPAGATION AND DECAY OF HYDROMAGNETIC WAVES IN AN ANISOTROPIC MEDIUM. S. A. Kaplan (Lvov Astronomical Observatory, Lvov, U.S.S.R.). Revs. Modern Phys., 32: 881 (Oct. 1960).

An investigation was undertaken of the propagation of hydromagnetic waves in a medium with anisotropy caused by a strong magnetic field where the product of the Larmor frequency and the mean free time of electrons is much greater than one, $\omega\tau \gg 1$. Linearization of the usual hydromagnetic equations, with Ohm's law for the anisotropic medium, permits solutions to be found in the form of three types of waves. In this case all these waves are interconnected. From a study of the structure of oblique shock waves in hydromagnetics, it was shown that if the direction of the propagation of shock is chosen along the x-axis, the vector $\{0, H_y, H_z\}$ rotates inside the shock front with the period: $p = 2\pi\eta_1\omega\tau \cos\vartheta/(v_x - H_x^2/4\pi J)$. It is concluded that this rotation of the plane of polarization in hydromagnetics is in some respect analogous to the rotation of the plane of polarization in the classical optics of an anisotropic medium. (B.O.G.)

10269 PINCH BUCKLING. K. O. Friedrichs (New York Univ., New York). Revs. Modern Phys., 32: 889-97 (Oct. 1960).

An investigation was made concerning the existence of equilibrium states of a pinched plasma with large deflections, and the stability of the states if they exist. It is suggested by analogy with the instability of an elastic structure under the action of a compressive shock that such states may exist. Such structures buckle when the critical compression is exceeded and may assume a stable buckled state with large deflections. While a thin rod assumes a stable buckled equilibrium, when the axial compressive force exceeds a critical value, the situation may be different for other structures. The primary cause of instability of a pinched plasma—assumed to be cylindrical—is the fact that the circumferential magnetic field strength in the vacuum outside the plasma decreases away from the plasma. The buckled states of plasma are exhibited with a satisfactory degree of approximation. These equilibrium states involve a wavy interface whose amplitude grows if the data of the problem are changed away from those values at which transition from stability to instability takes place. A consequence of the fact that buckled states exist for values at which the unbuckled state is stable is that the buckled states are unstable. (B.O.G.)

10270 ON HYDROMAGNETIC STABILITY OF STATIONARY EQUILIBRIA. E. Frieman and Manuel Rotenberg (Princeton Univ., Princeton, N. J.). Revs. Modern Phys., 32: 898-902 (Oct. 1960).

Bernstein et al., showed that the stability of a hydromagnetic fluid in static equilibrium could be determined by an energy principle formalism. Those methods are extended to the consideration of the stability of stationary equilibria. The considerations lack the powerful theorems available for systems governed by Hermitian operators, but it has been possible to obtain some general results for this case. Linearized equations of motion and the boundary conditions in a Lagrangian representation are discussed. Some properties of the equations and a general sufficient condition for stability are given. A general perturbation theory for small flow velocities is presented. A reformulation of the equations in hamiltonian form, and an application of the theory, calculated by Pytte, to a rotating stabilized pinch configuration are appended. (B.O.G.)

10271 ON THE STABILITY OF A PERIODIC FORCE-FREE FIELD WITH NEUTRAL LINES. E. Schatzman (Institut d'Astrophysique, Paris, France). Revs. Modern Phys., 32: 903-6 (Oct. 1960).

The field is supposed to be independent of $\underline{z}$ but is periodic in $\underline{x}$ and $\underline{y}$. $\underline{m}$ and $\underline{n}$ being integers, the field has neutral lines along the $\underline{z}$ axis for the coordinates: $kx = (m + \frac{1}{2})\pi$ and $ly = (n + \frac{1}{2})\pi$, $\underline{k}$ and $\underline{l}$ being the wave numbers of the periodic structure. The force-free field considered here has been derived for further application to the theory of sunspots and solar flares. Consideration is given for the stability problem using a uniform gas in which the $\underline{z}$ free field is imbedded. The contribution to stability of an arbitrary perturbation in the neighborhood of the neutral lines is discussed. Compared to the case of cusped geometries, the fluid is not confined by the magnetic lines of force and, consequently, has no reason for being stabilized by the curvature of the lines of force. (B.O.G.)

10272 STABILITY OF TWISTED MAGNETIC FIELDS IN A FLUID OF FINITE ELECTRICAL CONDUCTIVITY. R. J. Tayler (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Revs. Modern Phys., 32: 907-13 (Oct. 1960).

A formal solution is given for the problem of the stability of uniformly twisted magnetic fields in an incompressible inviscid fluid of finite scalar viscosity and electrical conductivity. The perturbed hydromagnetic equations in the conducting fluid can be reduced to a single 10th order differential equation which can be solved in terms of Bessel functions. The solution is formal in the sense that, when boundary conditions are applied, the problem is reduced to the solution of an extremely complicated transcendental dispersion relation. If there is no axial magnetic field and only axisymmetric perturbations are considered, the problem can be solved completely. If the magnetic field is twisted and perturbations other than axisymmetric perturbations are considered, there are always perturbation helices which exactly match the magnetic field helix. For the case of twisted magnetic fields and arbitrary perturbations, finite electric conductivity alone is considered. In the cases that can be solved completely, the growth rates for infinite and zero conductivity are the extreme values. In the cases considered it was found that, with a suitable

normalization, the growth rate for a fluid of low conductivity is greater than that for a fluid of high conductivity. The results cannot be applied to a compressible plasma but can be applied to a liquid conductor such as mercury or liquid sodium. (B.O.G.)

10273 ON THE THEORY OF HYDROMAGNETIC EQUILIBRIUM. L. Woltjer (Leiden Univ. Observatory, Leiden, Netherlands). Revs. Modern Phys., 32: 914-15 (Oct. 1960).

Recently a theory of hydromagnetic equilibrium, based on a variational principle, has been developed in which the invariants of the hydromagnetic equations have an important role. A discussion is given of an investigation of the limits of the applicability of this variational approach with respect to a generalization of the geometry and of the equations which describe the dynamical behavior of the plasma. The applicability of the integrals, $I_1 = \int A \cdot H d\tau$ and $I_2 = \int H \cdot v d\tau$, which were derived on the basis of the single-fluid equations, to a more general plasma was investigated. (B.O.G.)

10274 SOME RESULTS ON HEAT TRANSPORT BY CONVECTION IN THE PRESENCE OF A MAGNETIC FIELD. Yoshinari Nakagawa (Univ. of Chicago, Ill.). Revs. Modern Phys., 32: 916-18(Oct. 1960).

A review is given of investigations on the effects of an impressed magnetic field on heat transport by convection. The general situation is: Consider a horizontal layer of an electrically conducting fluid (mercury) of depth d bound between two constant temperature surfaces, the bottom surface at a higher temperature T_1 than the top surface T_2, and subject to an impressed magnetic field H. For maintaining constant temperature difference between the surfaces from the onset of convection, the layer of fluid attains a state of convective equilibrium. A summary is given of some experimental and theoretical results. Preliminary results have shown that to the first approximation, heat transport by convection, can be characterized by: $S = (1 + k) Ra - kRa_c$ for $Ra > Ra_c$, where S is the amount of heat transferred across a unit cross-sectional area per unit time, k is a constant, Ra is the Rayleigh number, and Ra_c is the critical Rayleigh number. Experiments have confirmed that the heat transport by overstable convection is reduced because of the phase difference, and have shown discontinuous increase in heat transport for higher temperature differences. This discontinuous increase in the heat transport may be explained as loss of definite phase difference and the transition toward turbulent convection. (B.O.G.)

10275 IDEALIZED PROBLEMS OF PLASMA DYNAMICS RELATING TO GEOMAGNETIC STORMS. Sydney Chapman (Univ. of Michigan, Ann Arbor). Revs. Modern Phys., 32: 919-33(Oct. 1960).

The main features and solutions to two problems of plasma dynamics which bear on the first phase of geomagnetic storms, which were solved by "particle" methods, are described. The changes in the solution, if consideration is given for some neglected factors, are discussed, particularly as regards the oblique impact of some of the particles on the magnetic field. Further idealized problems are formulated which are probably soluble by similar methods and which may increase the understanding of plasma dynamics and of geomagnetic storms. (B.O.G.)

10276 THEORY OF SUDDEN COMMENCEMENTS AND OF THE FIRST PHASE OF A MAGNETIC STORM. V. C. A. Ferraro (Queen Mary College, Univ. of London, Eng.). Revs. Modern Phys., 32: 934-40(Oct. 1960).

In previous theories concerning auroras and magnetic storms, interplanetary space was assumed to be void. Because of the recent accrual of evidence, which shows that there exists an interplanetary gas with densities of 100 to 1000 particles/cc, theories are proposed for the commencement and for the first phase of a magnetic storm. The only modification necessary for correcting a previous theory is that the geomagnetic impulse caused by the induced currents in the stream is propagated, not with the speed of light as was originally supposed, but with a finite speed which in the neighborhood of the earth approximates to the Alfvén velocity. The original theories are outlined along with the modifications to the theory of the first phase of a magnetic storm. Consideration is given for the motion of the quasi-shock wave in the neighborhood of the earth caused by the rapid increase of the earth's magnetic field. Illustrations are given from which it is seen that the disturbance is propagated through the interplanetary gas with the local Alfvén velocity. The time of propagation of the disturbance through the gas is derived. (B.O.G.)

10277 ON THE MAGNETODYNAMIC AND ADIABATIC EQUILIBRIUM OF A GASEOUS MASS WITH A UNIFORM ROTATIONAL AND GRAVITATIONAL MOTION. Cataldo Agostinelli (Univ. of Turin, Italy). Revs. Modern Phys., 32: 941-6(Oct. 1960).

A proposal is given to establish the equations of adiabatic equilibrium of a gaseous mass with an infinite electrical conductivity rotating uniformly around an axis passing through its center of pressure and subjected to the Newtonian attraction forces among single particles, assuming that the conductivity currents generate a magnetic field. It is demonstrated that the field must be symmetrical with respect to the rotational axis and the problem is reduced to the integration of two partial differential equations with two unknown functions: the field function and the fluid density. Particular cases are described when the transverse component of the magnetic field is zero and where the magnetic field is reduced only to a transverse component. The results have been applied to the case of a slowly rotating spheroidal gaseous mass with sufficiently weak magnetic field. (B.O.G.)

10278 SHOCK WAVES AND SHOCK-WAVE STRUCTURE IN MAGNETO-FLUID DYNAMICS. P. Germain (Univ. of Paris, France). Revs. Modern Phys., 32: 951-8 (Oct. 1960).

An investigation was made of the dissipative and nonlinear effects in the shock layer when the fluid is electrically conducted and subjected to a magnetic field. The assumptions were: the flow is plane and stationary; the magnetic field is in the same plane; all the physical quantities depend on the coordinate x only and are uniformly bounded for $-\infty < x < +\infty$. The dissipative effects are viscosity, thermal conductibility, and the inverse of the electrical conductivity. No assumption is required for the behavior of the coefficients of these effects with respect to the physical and thermodynamical quantities. A system of four differential equations with four unknowns is obtained when writing the equations for the problem. The system may be written in a compact form by using the dissipation energy and a generalized thermodynamical potential which is independent of the dissipation effects. It can be shown that there are at most four solutions, S_1, S_2, S_3, and S_4, for the equations which govern shock waves in a perfect-fluid flow theory, each of which is characterized by the value of the normal speed component relative to the three small-perturbation speeds. The transition from S_1 to S_2 (fast shock) is shown to be stable; from S_1 or S_2 to S_3 or S_4

(intermediate shock) can be proved as never stable; and from S_3 to S_4 (slow shock) may be stable but no general conclusion can be stated. The conclusions of previous works generally agree with those presented except for slow shock, where it was previously concluded that slow shock is always stable. (B.O.B.)

10279 HYDROMAGNETIC WAVES OF FINITE AMPLITUDE IN A PLASMA WITH ISOTROPIC AND NONISOTROPIC PRESSURE PERPENDICULAR TO A MAGNETIC FIELD. K. Hain, R. Lüst and A. Schlüter (Max-Planck-Institut für Physik und Astrophysik, Munich, Ger.). Revs. Modern Phys., 32: 967-72(Oct. 1960).

An investigation was made of the structure of hydromagnetic shock waves with reference to a stationary plane wave propagating in the absence of collisions perpendicular to a magnetic field. A previous investigation was made in which the plasma pressure was assumed to be zero. The discussion here is concerned with the assumption that the gas pressure perpendicular to the magnetic field is isotropic in one case and nonisotropic in another. (B.O.G.)

10280 ATTACHED STATIONARY SHOCK WAVES IN IONIZED GASES. H. Cabannes (Université d'Aix Marseille, Marseille, France). Revs. Modern Phys., 32: 973-6(Oct. 1960).

A study was made of steady flows about a wedge where there is an attached shock wave. The present solution was made for a magnetic field parallel to the fluid velocity with a zero electric field. The difference between the classical fluid mechanic solution and the present one is the consideration of the influence of the magnetic field. In the absence of a magnetic field, the solutions are identical. (B.O.G.)

10281 SOME GENERALIZATIONS IN ONE-DIMENSIONAL MAGNETO-GAS DYNAMICS. J. A. Shercliff (Univ. of Cambridge, Eng.). Revs. Modern Phys., 32: 980-6(Oct. 1960).

The generalizations are given in both the approximate and strict sense for the case of a transverse field. The transverse field shock structure is discussed considering the dominance of thermal, magnetic, and viscous diffusion. The results may be summarized by saying that the behavior is throughout qualitatively like that of a perfect gas provided the gas obeys the realistic conditions that $(\partial^2 p/\partial \tau^2)_{s \text{ or } I}$ and the expansion coefficient be positive. The assumption that the gas is in equilibrium throughout is rather less realistic in the shock process. (B.O.G.)

10282 FLOW IN DIRECT-CURRENT ELECTROMAGNETIC PUMPS. Vernon J. Rossow (Ames Research Center, Moffett Field, Calif.). Revs. Modern Phys., 32: 987-91(Oct. 1960).

The effects of the ends of the electric and magnetic fields on the steady one-dimensional channel flow of an electrically conducting fluid were studied experimentally and theoretically. Two methods are described which may be used to recover the one-dimensional character of the flow. It was found possible to obtain an electric field that is essentially one-dimensional, by choosing the center portion of the field produced by very long electrodes for the location of a rectangular magnetic field. Flow from such a pump, where the end effects are negligible, is evidenced by the uniformity of the stream. The disadvantage of this pump is that only about one-third of the current interacts with the magnetic field to increase the momentum of the stream. (B.O.G.)

10283 ON FLOWS OF CONDUCTING FLUIDS PAST BODIES. Isao Imai (Univ. of Tokyo, Japan). Revs. Modern Phys., 32: 992-99(Oct. 1960).

The general three-dimensional flow of a compressible, inviscid, perfectly conducting fluid in the presence of a uniform magnetic field is considered when the undisturbed flow and magnetic field are parallel. The flow is shown to be essentially similar to the ordinary flow of a hypothetical nonconducting gas with an appropriate pressure-density relation. General considerations are given to the small-perturbation theory of magnetohydrodynamic flows at large or small Reynolds numbers. Using the Stokes type approximation, the general expressions are obtained for the magnetic field and velocity, as well as the force and momentum acting on a body in the flow at small magnetic and ordinary Reynolds numbers. (B.O.G.)

10284 INVISCID FLOW PAST A BODY AT LOW MAGNETIC REYNOLDS NUMBER. G. S. S. Ludford (Univ. of Maryland, College Park). Revs. Modern Phys., 32: 1000-1003(Oct. 1960).

Considerations are given for the plane and axially symmetric flows of an inviscid flow which are dependent on the magnetic Reynolds number R_M and the ratio of a representative magnetic pressure to the dynamic pressure of the free stream, β. Assuming both β and R_M to be small, the equations of motion are developed for a weak applied magnetic field. The equations are then developed for a very strong magnetic field for the case where β is so large that βR_M is large, even through R_M is assumed to be small. The drag coefficient, which is proportional to $(\beta R_M)^{1/2}$, is given for a circular cylinder. (B.O.G.)

10285 RELATIONS BETWEEN PLASMA PHYSICS AND ASTROPHYSICS. L. Biermann (Max-Planck-Institut für Physik und Astrophysik, Munich, Ger.). Revs. Modern Phys., 32: 1008-1011(Oct. 1960).

The discussion begins by collecting some figures and relations from plasma physics as a background. Equations are developed which can be used to solve some of the theoretical difficulties arising from the behavior of charged particles in magnetic fields by visualizing a plasma as composed of two fluids, the ion gas and electron gas, coupled by a friction term. Some of the applications of these results are given for the problems of solar physics and of interplanetary space. A conclusion that may be drawn from the discussion is that, with the exception of the transient plasma tails of comets, there should be no interplanetary plasma different from the solar corpuscular radiation, since such an assumed medium would be accelerated as is observed for the comets. Also, the solar corpuscular radiation travels approximately radially through interplanetary space. It differs from the outer solar atmosphere both by its total energy and its rotational momentum. Some observational facts are discussed in connection with these conclusions. (B.O.G.)

10286 ENERGY BALANCE AND CONFINEMENT OF A MAGNETIZED PLASMA. B. Lehnert (Royal Inst. of Tech., Stockholm, Sweden). Revs. Modern Phys., 32: 1012-1019 (Oct. 1960).

The conservation theorems for mass, charge, momentum, and energy are considered for a partially ionized gas where ionization and charge exchange phenomena are included. The theory is applied to a rotating plasma, i.e., to a situation of interest in connection with rotating stars, in cosmogony, and in controlled thermonuclear fusion research. Important effects that have not been treated are the interactions with radiation fields by excitation, bremsstrahlung and synchrotron radiation, as well as two-stage ionization, volume recombination, multiple charge exchange collisions, plasma oscillations caused by electric charge separation, and the production of energy from nuclear reactions. (B.O.G.)

10287 POLAR, MAGNETIC, AURORAL, AND IONOSPHERIC PHENOMENA. E. H. Vestine (RAND Corp., Santa Monica, Calif.). Revs. Modern Phys., 32: 1020-28 (Oct. 1960).

A discussion is given concerning the aspects of magnetic storms which appear to arise from atmospheric sources, though their ultimate causes may be situated beyond the atmosphere. The intense electric currents flowing in the auroral regions are described with related spacial features of the polar and low latitude fields measurable by polar orbiting earth satellites. The earth as a mirror machine is described, and certain theoretical treatments successfully used in the laboratory are applied. It is shown that integral invariants of auroral particle motion can very successfully delineate the average auroral isochasms. Features of auroral morphology are discussed which seem explicable on the basis of stability considerations of plasma physics. (B.O.G.)

10288 ASSOCIATION PROBLEM IN STATISTICAL MECHANICS—CRITIQUE OF THE TREATMENT OF H. S. GREEN AND R. LEIPNIK. Michael E. Fisher (King's College, London, Eng.) and H. N. V. Temperley (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Revs. Modern Phys., 32: 1029-31(Oct. 1960).

It is pointed out that the Green–Leipnik solution of a two-dimensional lattice combinatorial problem (association problem) is manifestly incorrect. The reason for the error is shown to be a fallacious assumption made when applying the general mathematical theory to the problem which corresponds to distributing bonds over a plane p by q quadratic lattice (pq = n). The solutions quoted for various one-dimensional association problems are correct, but these problems can be solved more readily by an elementary direct argument. The present result can also be obtained from the Green–Leipnik approach if their assumption is corrected, but the labor involved is considerable and leads to a 17 × 17 matrix and most cross terms must be considered. The full two-dimensional case does not yield to either of these approaches and still represents a challenging problem. (B.O.G.)

10289 ON GREEN AND LEIPNIK'S METHOD FOR SOLUTION OF THE ASSOCIATION PROBLEM. Shigetoshi Katsura and Sakari Inawashiro (Tôhoku Univ., Sendai, Japan). Revs. Modern Phys., 32: 1031-32(Oct. 1960).

It is pointed out that the Green–Leipnik method for obtaining the partition function of the association problem in one-, two-, and three-dimensional lattices is not effective and the solutions for two and three dimensions are incorrect. The relations are given for the secular equation in the three-dimensional case and for the case of a rectangular lattice of nearest neighbors. (B.O.G.)

10290 INVESTIGATION OF THE ELECTRON DENSITY IN THE LINEAR PINCH WITH 8.7 mm WAVES. Hans Hermansdorfer (Technische Hochschule, Munich, Germany). Z. Naturforsch. 15a, 979-83 (Nov. 1960). (In German)

The plasma cylinder of a fast linear pinch was irradiated radially with a microwave beam (34.4 kMc, λ_0 = 8.7 mm), and the phase modulation of the wave reflected by the plasma was observed. Although Kerr cell pictures show a strong plasma contraction, the plasma layer with electron densities about 10^{13} cm^{-3} (the initial deuterium pressure corresponded to a particle density of $3 \cdot 10^{15}$ cm^{-3}), responsible for the reflection of the used microwaves, is much less than a few millimeters from the inner wall of the discharge tube. (auth)

10291 ON THE MOTION OF SHOCK WAVES ALONG A MAGNETIC FIELD. R. V. Polovin (Inst. of Physics and Technology, the Academy of Sciences, Ukrainian, S.S.R.). Zhur. Eksptl'. i Teoret Fiz., 39: 1005-7(Oct. 1960). (In Russian)

A shock wave excited in a hydromagnetic medium by a conducting piston moving along a magnetic force line, was considered. The conditions of nonevolutionality and of disintegration of the shock wave into two hydromagnetic shock waves were obtained. The supposition is put forward that such disintegration is one of the ways of forming of the filamentary nebulae. (auth)

10292 ON THE THEORY OF RUNAWAY ELECTRONS. A. V. Gurevich (Lebedev Inst. of Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1296-1307 (Nov. 1960). (In Russian)

The influence of a relatively weak electric field on the velocity distribution of plasma electrons in the high-velocity range is considered. An expression for the stationary electron distribution function is derived and analyzed. The flux of runaway electrons in a completely ionized plasma is determined. The effect of neutral plasma particles on this flux is taken into account. It is shown that under certain conditions instabilities in the plasma may occur during development of the discharge which are due to the runaway electron flux. The results obtained are in qualitative agreement with the experiments. (auth)

10293 INVESTIGATION OF MAGNETO-ACOUSTIC RESONANCE IN A PLASMA WITH AID OF DOUBLE ELECTRIC PROBES. V. D. Rusanov, B. I. Patrushev, I. A. Kovan, V. I. Garkusha, and D. A. Frank-Kamenetskiĭ. Zhur. Eksptl'. i Teoret. Fiz., 39: 1497-1502(Dec. 1960). (In Russian)

The concentration of a plasma in a magneto-acoustic wave was measured. It is shown that under magneto-acoustic resonance the ionization considerably and rapidly increases. The radial concentration distribution in the plasma was almost uniform. (auth)

10294 GYROTROPIC PROPERTIES OF A PLASMA DURING PROPAGATION OF AN EXTRAORDINARY WAVE. B. I. Patrushev, V. D. Rusanov, I. A. Kovan, V. V. Savichev, and D. A. Frank-Kamenetskiĭ. Zhur. Eksptl'. i Teoret. Fiz., 39: 1503-7(Dec. 1960). (In Russian)

Rotation of the wave and polarization vectors was detected experimentally during the propagation in a plasma of a wave with a frequency lying between the ionic and electron cyclotronic frequencies. (auth)

10295 ACCELERATION OF POSITIVE IONS IN AN EXPANDING VACUUM SPARK PLASMA. A. A. Plyutto. Zhur. Eksptl'. i Teoret. Fiz., 39: 1589-92(Dec. 1960). (In Russian)

Acceleration of positive ions to energies of 10^3 to 10^4 ev during rapid expansion of the plasma of vacuum sparks was detected. A brief description of a mechanism of acceleration of the ions by electrons capable of explaining the experimental facts is proposed. (auth)

10296 INVESTIGATION OF MAGNETIC MIRROR CONFINEMENT OF A PLASMA. [PART] I. M. S. Ioffe, R. I. Sobolev, V. G. Tel'kovskiĭ, and E. E. Yushmanov. Zhur. Eksptl'. i Teoret. Fiz., 39: 1602-11(Dec. 1960). (In Russian)

Confinement of a hydrogen plasma with a density of the order of 10^9 cm^{-3} by a cylindrical magnetic mirror was studied. The mean ion energy in the plasma was 1 to 2 kev, electron energy was about 10 ev, and minimal neutral gas pressure under working conditions was 3 to $4 \cdot 10^{-7}$ mm Hg. Confinement was studied by measuring the half life of the fast ions. It was found that ion escape from the trap is

much more rapid than would be expected on basis of charge exchange and scattering. Anomalous ion losses were observed only when plasma was present in the trap. When the charged particle density drops to such a value that the Debye range is of the same order as the trap dimensions the losses disappeared. (auth)

10297 INTRODUCTION TO THE THEORY OF IONIZED GASES. J. L. Delcroix. Translated from the French by Melville Clark, Jr., David J. BenDaniel, and Judith M. BenDaniel. Interscience Tracts on Physics and Astronomy. Number 8. New York, Interscience Publishers, Inc., 1960. 159p. Cloth: $4.50; Paper: $2.50.

A theoretical study of the properties of ionized gases is presented. The microscopic, rather than the macroscopic, description is extensively used, and the foundation of the hydrodynamic methods is discussed. Free electron, weakly ionized, and strongly ionized gases are considered. Wave propagation, pinch effect, and other topics more easily treated by the hydrodynamic method are omitted. (D.L.C.)

10298 PLASMA PHYSICS. James E. Drummond. New York, McGraw-Hill Book Company, Inc., 1961. 399p. $12.50.

Some of the general aspects of plasma physics, as well as current research problems and examples of solution methods, are outlined and discussed. The 14 chapters are divided into three groups: basic plasma theory, magnetohydrodynamics, and microwave plasma physics. Topics discussed include quantum plasma physics, spectra of systems of interacting particles, statistical mechanics of reversible processes in plasma dynamics, amplifying and evanescent waves, review of magnetohydrodynamics, the Bennett Pinch, stability of relativistic self-focusing strains, electrical properties of shock waves, transverse plasma waves and vortices, plasma power absorption, microwave diagnostics for controlled fusion research, plasma magnetron theory, and plasma research at MIT. (M.C.G.)

10299 APPARATUS AND METHOD FOR CONFINING A PLASMA. (to U. S. Atomic Energy Commission). British Patent 859,459. Jan. 25, 1961.

An apparatus is described for stably confining a plasma. In this apparatus, a plasma is established in an evacuated zone and a plasma-magnetic field configuration is established in the zone with an interface of the free-boundary type which has cusps and is everywhere convex toward the plasma. Several embodiments of this apparatus are given. (D.L.C.)

10300 APPARATUS FOR GENERATING A HIGH ENERGY PLASMA. (to U. S. Atomic Energy Commission). French Patent 1,203,418. July 27, 1959.

A thermonuclear device or device to produce neutrons is described which has a toroidal container. In radial planes of the torus, magnetic coils are located around it and electrodes are disposed on the inner side of the coils in such a way that in definite regions of the torus the magnetic and electric fields cross substantially at right angles. A deuterium plasma, which is generated in the vessel, is trapped in these regions with crossed fields, and if the temperature is high enough, fusion reactions take place between the deuterium ions. (NPO)

10301 APPARATUS PRODUCING RUSHES OF CURRENT. (to Siemens-Schuckertwerke A. G.). French Patent 1,204,822. Aug. 10, 1959.

A large number of capacitors are connected in parallel to the electrodes of a discharging device by means of two horizontal circular conducting plates; these plates are separated by a thin layer of dielectric material and support the discharging device in the center. The capacitors are arranged concentrically with the discharging device, preferably in conducting cages under the lower plate; these cages are electrically connected to that plate and to one of the electrodes of the capacitors, the other electrodes being connected to the upper plate through holes in the lower plate. (NPO)

10302 THERMONUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,205,662. Aug. 17, 1959.

An annular gas discharge is induced in a toroidal vessel by a number of sectors of conducting layers on the torus between which layers voltage pulses are applied. These voltage pulses can be supplied by transmission lines. (NPO)

10303 METHOD AND DEVICE TO PRODUCE ON AN INDUSTRIAL SCALE CONTROLLED THERMONUCLEAR REACTIONS AND TO UTILIZE THE RELEASED ENERGY. N. C. Cristofilos. French Patent 1,209,635. Sept. 21, 1959.

The "Astron" thermonuclear reactor consists of a vessel in which is generated a homogeneous magnetic field and larger magnetic fields at the ends of the vessel. Electrons with a relativistic energy are injected into this vessel in such a way that they will rotate in a cylindrical layer. In this way a region is formed in which the electric and magnetic fields are suitable for the capture and heating of a thermonuclear plasma. The electrons are injected tangentially at one end of the vessel, where regions with varying magnetic fields transport the electrons to the region with the homogeneous magnetic field. (NPO)

10304 IMPROVEMENTS TO THERMONUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,210,767. Oct. 5, 1959.

The wall of a vessel in which a discharge of high-tension current is to take place is provided internally with a large number of mutually insulated little plates which are so small that no arcs are generated to them. The plates are mutually parallel and partly overlap each other so that practically no photons or ions from the discharge can penetrate between them. (NPO)

10305 THERMONUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,210,768. Oct. 5, 1959.

A thermonuclear reactor of the type in which an annular gas discharge is generated in a toroidal vessel is provided with additional windings on the torus to stabilize the discharge. Adjacent windings are at a distance from each other that is smaller than the radius of cross section of the torus and the currents in adjacent windings are in opposite directions. (NPO)

10306 IMPROVEMENTS TO THERMONUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,210,769. Oct. 5, 1959.

The ionized fuel gas in the constricted gas discharge of a thermonuclear reactor is heated by injection of high-energy fuel particles. These particles are supplied by an ion source, producing high-energy ions that can be neutralized by exchange of charge with a neutral gas. (NPO)

10307 THERMONUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,210,770. Oct. 5, 1959.

The annular gas discharge in a toroidal vessel of a thermonuclear reactor is shielded from the wall of the torus by a continuous covering having an electrical resistance around the circumference of the torus that is much higher

than the resistance of the discharge. The covering can be undulated to increase the effective length of the circumference and can be made of stainless steel. (NPO)

10308 FUSION REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,211,151. Oct. 5, 1959.

In a thermonuclear reactor an annular gas discharge is induced by a short high-voltage pulse from a first excitation circuit in a primary winding of an impulse transformer of which the discharge constitutes the secondary winding. When the high tension pulse has fallen to a low value, the induced current is maintained at a high value during a relatively long time by coupling the discharge to a low voltage of long duration from a second excitation circuit. Both excitation circuits can be connected in series and after the high-voltage pulse has been switched off the second circuit can produce the voltage by way of a delay line and, if desired, a second transformer. (NPO)

10309 APPARATUS TO PRODUCE CONTROLLED NUCLEAR FUSION REACTIONS. (to United Kingdom Atomic Energy Authority). French Patent 1,211,240. Oct. 5. 1959.

The patent describes an apparatus for producing controlled nuclear fusion reactions in a gas discharge in a toroidal vessel containing on the inside a toroidal insert of high resistance. This inner torus carries a series of separate conductors along its smaller circumference; these serve to counteract the penetration of the stabilizing axial magnetic field to the inside of the inner torus. If the inner torus has an undulating surface (e.g., undulations in the direction of the circular axis), the conductors can conveniently be rings lying in the troughs of the undulations. The axis of the inner torus can coincide with the equilibrium axis of the discharge. (NPO)

10310 THERMONUCLEAR REACTOR. (to U. S. Atomic Energy Commission). French Patent 1,212,290. Oct. 19, 1959.

A thermonuclear reactor of the stellarator type is described which comprises a tube in the shape of a figure 8 in which tube a reactive gas is retained by a constant magnetic field. The gas is heated ohmically to about 10^6°K by an induced current pulse and then to about 10^8°K by alternating magnetic fields in wider parts of the tube. Charged particles, which are near the wall of the tube, are directed along lines of magnetic force into a so-called diverter where they are pumped away. The nuclear radiation produced is moderated and absorbed in liquids that circulate around the tube. (NPO)

10311 THERMONUCLEAR REACTOR. (to U. S. Atomic Energy Commission). French Patent 1,218,000. Dec. 14, 1959.

A thermonuclear reactor of the stellarator type comprising an endless tube in which a reactive gas is retained by a constant magnetic field is described. This magnetic field is produced by the usual magnetic coil on the tube and also by a number of helicoidal windings that add a transverse multipolar field to the axial field. The additional field produces some rotational transform in the lines of magnetic force, which means that the latter generally do not return to the same point after going around the tube. This rotational transform varies with the distance from the axis of the tube and thus decreases instabilities of the generated gas discharge. (NPO)

10312 APPARATUS TO PRODUCE NUCLEAR FUSIONS. (to Siemens-Schuckertwerke A. G.). French Patent 1,221,825. Jan. 18, 1960.

Nuclear fusion is brought about in a pinched gas discharge produced by a high-frequency generator coupled to the gas discharge by a delay line consisting of coils and capacitors. Transverse circular magnetic or electric fields can also be produced if desired by a resonant cavity or a wave guide surrounding the gas discharge tube. In addition, there can be an axial stabilizing magnetic field. (NPO)

10313 METHOD OF DESTROYING NEUTRAL PARTICLES IN THERMONUCLEAR REACTORS. (to U. S. Atomic Energy Commission). French Patent 1,222,257. Jan. 18, 1960.

A plasma confined by a magnetic field is heated by injection of deuterium molecule ions which give atomic ions in a special type of carbon arc parallel to the magnetic field in the thermonuclear reaction region. The injected current of ions has to be greater than a given value, in order to ensure that ionization of any neutral particles present by the atomic ions predominates over charge exchange between such neutral particles and the atomic ions, this latter process constituting an energy loss. (NPO)

10314 APPARATUS PRODUCING SHOCK WAVES IN RAPID SUCCESSION, PREFERABLY TO CAUSE THERMONUCLEAR REACTIONS. P. Schmidt. French Patent 1,223,257. Feb. 1, 1960.

In a cylindrical or spherical vessel, repeated shock waves are produced by injection of an explosive mixture through a great number of openings in the wall and ignition of the thin layer of explosive mixture formed near the wall of the vessel. This ignition can be brought about by the previous shock wave returned by reflection. Thus at the center of the vessel the temperature can be high enough to allow fusion of injected hydrogen to take place. The heat produced can be carried off by evaporation of water. (NPO)

10315 MAGNETIC END BARRIERS FOR CONTROLLED FUSION REACTORS. (to U. S. Atomic Energy Commission). French Patent 1,223,778. Feb. 1, 1960.

Magnetic mirrors in cylindrically shaped vessels in which controlled fusion reactions are to take place are made of a series of solenoids which are at some distance from each other around the ends of the vessel. There the magnetic field produced in axial direction is alternately strong and small. A plasma is injected into the region with a small magnetic field, these regions being in axial directions larger than the mean free path of a particle in the plasma. The magnetic mirror is made still better by arranging for a gradual increase of all magnetic fields from the fusion region to the outside of the vessel. The injection of plasma into the regions with a small magnetic field ensures that the fusion region is kept supplied with plasma. (NPO)

10316 CO-AXIAL DISCHARGES. J. S. Luce and L. P. Smith (to U. S. Atomic Energy Commission). U. S. Patent 2,961,558. Nov. 22, 1960.

An apparatus is described for producing coaxial arc discharges in an evacuated enclosure and within a strong, confining magnetic field. The arcs are maintained at a high potential difference. Electrons diffuse to the more positive arc from the negative arc, and positive ions diffuse from the more positive arc to the negative arc. Coaxial arc discharges have the advantage that ions that return to strike the positive arc discharge will lose no energy since they do not strike a solid wall or electrode. These discharges are useful in confining an ionized plasma between the discharges and have the advantage of preventing impurities from the walls of the enclosure from entering the plasma area because of the arc barrier set up by the cylindrical outer arc. (auth)

Shielding

10317 (NAA-SR-Memo-5299) PATCH, AN IBM 709 PROGRAM FOR CALCULATING GAMMA-RAY BUILDUP FACTORS FOR MULTI-LAYERED SHIELDS. P. Spiegler (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 20, 1960. 78p.

PATCH is an IBM 709 Fortran program for computing the dose, energy, and energy absorption build-up factor for multi-layered slab geometry shields. The code allows for n regions and six materials with a maximum of seven mesh points per region. The input data consist of the number of regions, the number of materials, their atomic numbers, and the γ and energy absorption coefficients of each material. Typical running time for a one-region problem with five internal mesh points is less than 1 min. The running time for a multiregion problem is linearly proportional to the running time of a one-region problem. (auth)

10318 (NP-9430) GAMMA RAY SCATTERING. Seventh Quarterly Technical Progress Report (Covering Period June 18, 1960 through September 18, 1960). J. P. Church, R. A. Karam, K. R. M. Rao, and J. A. Wethington, Jr. (Florida. Univ., Gainesville). 12p. Contract NOas 59-6013-c.

The angular distributions of radiations emerging from a lead shield and from polyethylene-lead shields were studied. A 1-curie Co^{60} source was used. The data are expressed as the ratio of the counting rate from one shield to the counting rate from the standard shield. (W.D.M.)

10319 (TID-6302) PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). 226p. (XDC-60-6-70).

Twenty-one papers were presented on radiation shielding. Separate abstracts were prepared for each paper. (B.O.G.)

10320 (TID-6302(Paper 1) A METHOD FOR COMPUTING A GENERALIZED EFFECTIVE FAST NEUTRON REMOVAL CROSS SECTION. K. B. Hanchon (General Electric Co. Aircraft Nuclear Propulsion Dept., Evendale, Ohio). Paper 1 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 6p

An analytical method for computing a generalized effective neutron removal cross section is discussed. Such a cross section would be a function of backing material and source-receiver distance, and would be specifically oriented toward a slab geometry. Discussion of results obtained from the method are presented. (auth)

10321 (TID-6302(Paper 2)) A MONTE CARLO PROGRAM FOR AIR-SCATTERED NEUTRONS. J. E. MacDonald and A. Trampus (General Electric Co. Aircraft Nuclear Propulsion Dept., Evendale, Ohio). Paper 2 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING: OCTOBER 14-15, 1959. 7p.

A description is given of the application of the Monte Carlo method in the calculation of the energy and angular distribution of neutrons scattered in air. The events considered are: isotropic elastic scattering, anisotropic elastic scattering, inelastic scattering, radiative capture, and absorption without subsequent particle emission. The probability density and scoring functions are exhibited which will make up the expected values that are to be estimated by random sampling techniques. These basic equations are shown to yield to such variance reducing methods as statistical estimation, importance sampling, and quota sampling. (auth)

10322 (TID-6302(Paper 3)) RECENT FISSION GAMMA-RAY SPECTRAL MEASUREMENTS. F. C. Maienschein, R. W. Peele, and T. A. Love (Oak Ridge National Lab., Tenn.). Paper 3 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 13p.

Measurements of the γ-ray spectrum closely associated in time with the fission of U^{235} by thermal neutrons were extended down to 10 kev with a single-crystal spectrometer. Preliminary results indicate a photon yield which varies between 6 and 15 photons/fission/Mev for energies from 10 to approximately 600 kev except at the heavy fission-fragment x-ray peak where the yield increases to about 24 photons/fission/Mev. In another investigation, an unrefined measurement of the gross spectrum of γ rays associated with the thermal fission of U^{235} was made with a three-crystal pair spectrometer and an irradiated U^{235} foil. Within the limitations, the results roughly agree in spectral shape with the data of Motz and with a summation of the earlier prompt-fission and fission-product data. (auth)

10323 (TID-6302(Paper 4)) A COMPARISON OF EXPERIMENTAL GAMMA-RAY RESPONSE MEASUREMENTS WITH CALCULATIONS FOR AN 8-IN. RIGHT CYLINDRICAL NaI(Tl) CRYSTAL. G. T. Chapman and T. A. Love (Oak Ridge National Lab., Tenn.). Paper 4 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 8p.

A right circular, cylindrical NaI(Tl) crystal 8 in. in diameter and 8 in. long was tested at the Bulk Shielding Facility. The crystal was formed by optically coupling two smaller crystals, each 8 in. in diameter and 4 in. long, together in such a way that the composite gave results comparable to a single crystal. By mounting a 2-in.-thick crystal containing a $\frac{1}{2}$-in.-diameter axial hole through it on the end of the large crystal and taking the anticoincidence spectrum from the large crystal, it was shown that the ratio of the peak area to the total area could be improved by the addition of a well in the crystal. The experimental data were compared with a Monte Carlo calculation for a crystal of the same size. (auth)

10324 (TID-6302(Paper 5)) EFFECTIVE NEUTRON REMOVAL CROSS SECTION OF ZIRCONIUM. J. M. Miller (Oak Ridge National Lab., Tenn.). Paper 5 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 4p.

The effective removal cross section of zirconium was determined as 2.36 ± 0.12 barns on the basis of thermal-neutron flux measurements made at the LTSF beyond two slabs of zirconium (1.8 wt.% hafnium), each 54 by 49 by 2 in. A mass attenuation coefficient (Σ_R/ρ) based upon the removal cross section and a measured density of 6.54 g/cm^3 is $(1.56 \pm 0.08) \times 10^{-2}$ cm^2/g. (auth)

10325 (TID-6302 (Paper 6)) PREDICTION OF THERMAL-NEUTRON FLUXES IN THE BSF FROM LTSF DATA. E. P. Blizard and A. D. MacKellar (Oak Ridge National Lab., Tenn.). Paper 6 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 6p.

Predictions of the thermal-neutron fluxes to be expected near the Bulk Shielding Reactor were made on the basis of Lid Tank Shielding Facility experimental data transformed to the BSR geometry. The predicted fluxes are higher than the measured fluxes by 15 to 25% for distances closer than 60 cm, but they are essentially in agreement for larger distances. At a distance of 125 cm, the predicted flux was only 1% too low. (auth)

10326 (TID-6302(Paper 7)) MONTE CARLO CODE FOR THE CALCULATION OF RESPONSE FUNCTIONS OF GAMMA-RAY SCINTILLATION DETECTORS. C. D. Zerby (Oak Ridge National Lab., Tenn.). Paper 7 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 10p.

A Monte Carlo code was written for the IBM-704 computer for calculations of the γ-ray response functions of NaI and xylene scintillation counters. The counter geometry can be either a right cylinder or a right cylinder with one conical end. The source is restricted to a monoenergetic source of arbitrarily chosen energy of 0.005 to 10.0 Mev. The treatment of the primary incident radiation takes into account Compton scattering, pair production, and the photoelectric effect. The secondary bremsstrahlung and annihilation radiation are considered in the case of a NaI crystal. The particular Monte Carlo method used is designed for minimum statistical error in the so-called "Compton tail" of the spectrum. (auth)

10327 (TID-6302(Paper 8)) DETERMINATION OF NEUTRON AND SECONDARY PHOTON SPECTRA FROM A THICK LAMINATED SHIELD WITH SPHERICAL SYMMETRY. Eugene Toll (Naval Air Development Center, Johnsville, Penna.). Paper 8 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 10p.

A Monte Carlo program, evolved for the photon problem, is being applied by using photon source data from neutron fluxes calculated by a combination of age and diffusion theory. A modification of the Carlson S_n method and a direct analytical method are described which were considered for solving the integro-differential transport equation in the neutron spectra determinations. An analytical solution was developed for the case of isotropic scattering in the laboratory system. (B.O.G.)

10328 (TID-6302(Paper 9)) APPLICATION OF THE CARLSON S_n-METHOD TO SHIELD CALCULATIONS. N. Edmonson, Jr., J. J. Henrick, and T. A. Moss (Convair, Fort Worth, Tex.). Paper 9 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 15p.

The Carlson S_n-method is being adapted to the calculation of angular and total flux distributions in shielding configurations. Accordingly, computational procedures for spherically symmetric shields were developed which accounts for the anisotropy of elastic scattering of neutrons, Preliminary calculations for a water shield gave flux distributions that compare favorably with the results of moments methods and Monte Carlo calculations. (auth)

10329 (TID-6302(Paper 10)) RESULTS OF AN OPTIMIZATION PROCEDURE. W. Cranford and R. A. Miller (Convair, Fort Worth, Tex.). Paper 10 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 10p.

Some results are reported on reactor and crew-compartment shields minimized by an optimization procedure called GYPSY. For a fast-neutron shield, the question of the adequacy of using a representative point source appears to be settled affirmatively. The effect of optimization of a crew shield for different point detector positions was investigated. (auth)

10330 (TID-6302(Paper 11)) MONTE CARLO CALCULATIONS OF FAST-NEUTRON ENERGY SPECTRA IN AIR. M. B. Wells (Convair, Fort Worth, Tex.). Paper 11 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 18p.

Results are presented of Monte Carlo air-scattering calculations for source-neutron energies above the threshold energy of inelastic scattering. Energy and angular distributions of the scattered neutron flux and angular distributions of the scattered dose rate are given for point isotropic monoenergetic sources at source-detector separation distances to 200 ft. The results are compared with calculations by Holland and Richards and by Zerby to evaluate the effect of inelastic scattering on the scattered energy spectrum. (auth)

10331 (TID-6302(Paper 12)) CREW SHIELD SHAPING. K. M. Simpson, C. C. Douglass, and H. E. Stern (Lockheed Aircraft Corp., Marietta, Ga.). Paper 12 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 8p.

A method for shaping the shielding on the sides of a cylindrical crew compartment is being developed. The shield is designed to achieve minimum weight subject to the requirement of a specified weighted average dose rate along the compartment center line. A machine program was written for a single component of radiation in which attenuation through a single shield material and angular distribution inside are incorporated in the form of general subroutines. (auth)

10332 (TID-6302(Paper 13)) A MONTE CARLO CALCULATION OF THE TRANSPORT OF NEUTRONS THROUGH IRON SLABS. M. O. Burrell and D. L. Cribbs (Lockheed Aircraft Corp., Marietta, Ga.). Paper 13 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 10p.

A Monte Carlo sampling is used to calculate the transmitted number current, number flux, dose, and the dose albedos of neutrons incident on an iron slab. A plane parallel source of monoenergetic neutrons with a number current density of 1 neutron/cm^2-sec is incident from a vacuum upon an iron slab of finite thickness. Transmission factors and linear buildup factors are computed for the above quantities. The dose transmission and the dose albedo are calculated for each of 120 equal solid angles. Gamma rays from inelastic scattering are recorded as a function of energy and penetration depth. (auth)

10333 (TID-6302(Paper 14)) CYLINDRICAL SHIELD MONTE CARLO. C. W. Hill (Lockheed Aircraft Corp., Marietta, Ga.). Paper 14 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 12p.

Monte Carlo calculations of single air-scattered γ-transfer functions were performed using a cylindrical geometry. Center line dose was calculated for a typical case. An estimate of the variation of dose along the axis is shown. End effects were approximated by a simple cutoff. (auth)

10334 (TID-6302(Paper 15)) NUCLEAR SHIELDING FOR SPACE ENVIRONMENT— THE SCATTERING SHIELD. Carl N. Klahr and Kalman Held (TRG, Inc., Syosset, N. Y.). Paper 15 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 14p.

Shielding of a nuclear reactor in a space vehicle should be designed to eliminate radiation, predominantly by scattering it into space rather than by absorption. This can eliminate much of the multiply scattered radiation (build-up) that would normally contribute to the dose. The following general rules for nuclear shadow shielding in space environment constitute what may be called the space scattering principles: (1) multiple splitting of the shadow shield to increase the probability of scattering into space; (2) shaping of each shadow disk to increase scattering into

space; (3) reliance on good scatterers with more isotropic cross section; and (4) the possibility of using low density materials without weight penalty because of the one dimensional geometry. Some schematic calculation results are presented. (auth)

10335 (TID-6302(Paper 16)) HIGH EFFICIENCY MONTE CARLO CALCULATION OF Na^{24} AND BREMSSTRAHLUNG GAMMA PENETRATION. R. Steinberg and R. Aronson (TRG, Inc., Syosset, N. Y.). Paper 16 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 11p.

TRG's slab γ-ray code, TRIGR-P, was modified to give improved results for low energies above the cross section minimum in heavy materials. A series of calculations for transmission of Na^{24} radiation (2.75- and 1.38-Mev photons) through aluminum, iron, and lead was run for five to six thicknesses of from 2 to 12 mean free paths at the higher energy for six incident angles varying from normal to 75° with the normal. There were 192 problems for which both doses and spectra were obtained. The standard deviations for the doses were about 5% for 0, 15, and 30° incidence and about 10% for the larger angles. A few problems gave 15% deviations or more for 60 to 75° on aluminum. The Morton similarity transformation was used to make it possible to obtain results for several thicknesses at once. Spectra from 8- and 10-Mev bremsstrahlung radiation transmitted through 4 and 6 in. of lead were computed and compared with the experimental results. (auth)

10336 (TID-6302(Paper 17)) GAMMA PENETRATION BY TRANSMISSION MATRIX METHOD. D. Yarmush (TRG, Inc., Syosset, N. Y.). Paper 17 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 8p.

A code for computing transmission and reflection matrices for γ rays on slabs was written and debugged. The code first computes an auxiliary matrix giving the properties of infinitely thin slabs by using empirical cross sections and the Klein-Nishina formula. The flux is represented by dividing the energy range into intervals and by using cosine powers for separate expansions in angle over the forward and backward hemispheres. An option allows for other methods of angular representation, e.g., the half-range Legendre polynomials. Preliminary numerical results are given. (auth)

10337 (TID-6302(Paper 18)) GAMMA-RAY PENETRATION INTO THE COMPARTMENTS OF A LIGHT AIRCRAFT CARRIER. S. Tomoeda, W. E. Kreger, M. B. Hastings, and W. G. Miller (Naval Radiological Defense Lab., San Francisco). Paper 18 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 21p.

The penetration of γ rays into compartments of an aircraft carrier from three radioisotopes was measured. Co^{60} (1.25 Mev), Cs^{137} (0.66 Mev), and Ir^{192} (0.38 Mev) sources were exposed at numerous points on the flight deck, and Landsverk air-wall equivalent dosimeters were used to measure dose in two general areas of the ship and at three different deck levels. Average dose rates and transmission factors were calculated by integration of the data to represent the case of uniform contamination of 1 curie per square foot. Point source data were compared with data taken using a uniformly distributed source. Effective shielding thicknesses of a ship's structure were determined from experimental data and compared with known structural thicknesses. Energy dependence of the shielding effectiveness can be adequately determined by using attenuation coefficients and build-up factors for the energies involved. (auth)

10338 (TID-6302(Paper 19)) RELATIVE CONTRIBUTIONS OF SCATTERED AND SECONDARY RADIATION INSIDE A REALISTIC CREW SHIELD. L. S. Burns, Jr. (General Electric Co. Aircraft Nuclear Propulsion Dept., Evendale, Ohio). Paper 19 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 13p.

Analytical calculations were made of the dose rate inside a crew shield as a function of the emitted radiation energy and the angle of departure from the reactor shield. Scattering calculations were made by single scattering methods. Calculations were made for (n,α) capture in air, inelastic scattering in air, thermal neutron capture in the crew shield, and thermalization of fast neutrons and capture of those neutrons in the crew shield. It is believed that this kind of study will prove highly useful in early planning stages of reactor shield design. (auth)

10339 (TID-6302(Paper 20)) COMPARISON OF CALCULATED AND MEASURED WATER CENTERLINE DATA. A. W. Casper (General Electric Co. Aircraft Nuclear Propulsion Dept., Evendale, Ohio). Paper 20 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 9p.

Dose rates and thermal fluxes were measured in water at the ORNL Bulk Shielding Facility and at the GE Source Plate Facility at Battelle Memorial Institute. The measured values are compared with point kernel calculations of the dose rates and thermal fluxes calculated by a combined diffusion theory-point kernel approach. (auth)

10340 (TID-6302(Paper 21)) CALCULATION OF NEUTRON SPECTRA FROM SLOWING DOWN MODELS. A. H. Barnett and J. R. Terrall (General Electric Co. Aircraft Nuclear Propulsion Dept., Evendale, Ohio). Paper 21 of PAPERS FROM SEVENTH SEMIANNUAL SHIELDING INFORMATION MEETING, OCTOBER 14-15, 1959. 10p.

A slowing down model is a simple representation of the angle-integrated Boltzmann equation whereby energy loss in collisions is taken into account in some kind of approximation, which may be made quite good. Probably the greatest advantage in using a slowing down model lies in its replacement by a simple first-order differential equation in energy of the original integral equation for which there are no known mathematical methods of obtaining a solution in closed form. From this differential equation, explicit solutions for flux spectra can be calculated. Several slowing down models are exhibited and an idea of their accuracy is given. (auth)

10341 THE ATTENUATION OF GAMMA RAYS BY CONCRETE AND BY CERTAIN SOILS. P. N. V'yugov, K. S. Goncharov, V. S. Dementiĭ, and A. M. Mandrichenko. Atomnaya Energ. 10: 76-9(Jan. 1961). (In Russian)

The economic aspects of soil and sand shielding are discussed. Tabulated data for 1-m^3 of various shielding materials for a 2-Bev linear accelerator indicate that large savings result from replacing concrete by soil and sand. (R.V.J.)

10342 CHAIN-LIKE PACKING MATERIAL FOR SEALING AGAINST RADIOACTIVE RADIATION. German Patent 1,057,268. Kerntechnik, 2: 359(Nov. 1960). (In German)

A chain-like plastic packing material for sealing against radioactive radiation is described. The material consists of metallic particles (lead, bismuth, or cadmium) of a size less than 12 μ (80 screen meshes per cm^2) which are coated

with a thin film of binder. The mixture is then pressed in an extrusion press under a pressure of 35 atm, so that the density is 9. The patent application contains further theoretical metallographic considerations on the occurrence of this effect. The following were used as typical mixtures: 15 wt.% of a compressor lubricant (containing 72% heavy motor oil, ~20% stearic acid, aluminum, and a mineral filler) and 85 wt.% lead powder or 10 wt.% of a mixture of light and heavy lubricants with medium viscosity and 90 wt.% lead powder. Other metal powders can be used in place of the lead powder. Any oil that forms a coating film on metal particles can be used. The choice of the components depends on the type and conditions of application, the space to be filled, and the temperature. For the sealing of fissures, rents, or leaks in the presence of active radiation or outlets, such a material, especially with lead or bismuth, would prove very good. The metal particles have, in their passage through the extrusion press, the inclination to aggregate on the outer surface of the rod-like moldings so that a type of flexible metal strand is obtained which can be shaped easily to be worked in fissures or grooves. (auth)

Theoretical Physics

10343 (JINR-E-485) ON THE ASYMPTOTIC AND CAUSALITY CONDITIONS IN QUANTUM FIELD THEORY II. F. Kaschluhn (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1960. 28p. (E-485).

The conclusions reached in a recent paper on the connection between the interacting field operator approach to quantum field theory of Lehmann, Symanzik, and Zimmermann and the functional derivative approach to quantum field theory of Bogolubov are established in more detail. It is shown that Bogolubov's causality condition is a necessary integrability condition for the retarded and advanced solutions of the inhomogeneous Klein-Gordon equation. Associated with this, the fact is investigated in some detail that the transformation operator which connects the interacting field operator with the incoming or outgoing free-field operator can only be unitary up to a positive renormalization constant smaller than one for real interactions. The differences existing between both approaches with respect to the extrapolation of the reduced S-matrix elements off the mass shell are discussed. Concluding, it is shown that it is without any importance for the analytic behavior of the reduced S-matrix elements in the interacting field operator approach considered in the theory of dispersion relations whether the causality condition for the interacting field operator in the commutator form is fulfilled. (auth)

10344 (NP-9709) SELF-CONSISTENT FIELD THEORY OF NUCLEAR SHAPES. Technical Report No. 5. Michel Baranger (Carnegie Inst. of Tech., Pittsburgh). [nd]. 20p. Contract Nonr-760(15), NR-012-202.

The Hartree-Fock equations are generalized to include pairing effects on the same footing with field-producing effects. In addition to the Hartree potential, there enters a pairing potential. When applied to a spherically symmetric shell-model Hamiltonian, these equations may possess deformed solutions. Application is made to pairing plus quadrupole forces, with results identical to those of Belyaev and Kisslinger and Sorensen. The spherical shape becomes unstable when some collective vibration of the spherical nucleus reaches zero frequency. (auth)

10345 (NP-9796) MOBILITY OF ION IN A SYSTEM OF INTERACTING BOSE PARTICLES. Technical Report No. 5. Ryuzo Abe and Ko Aizu (Northwestern Univ., Evanston, Ill.). [1960?]. 35p. Contract Nonr 1288(13), NR-372-190.

The transport property of an ion in a dilute Bose-Einstein gas subject to an external electric field is investigated through Boltzmann equation approach. By means of the Bogolyubov transformation, the interaction hamiltonian between ion and elementary excitation is obtained, and the cross section for the scattering of the ion from phonons or rotons is calculated. The solution to the Boltzmann equation is obtained by the use of a variation principle, and the temperature dependence of ion mobility is shown to be T^{-4} at very low temperature regions where phonon excitations are more important than rotons. At higher temperatures where roton excitations are important the temperature dependence is shown to be $T^{-1} \exp(\Delta/kT)$, where Δ is the excitation energy of roton. The agreement in absolute magnitude with the experimental data in liquid helium is obtained by choosing reasonable value of parameters both in higher and lower temperature regions. Comparison with the Khalatnikov and Zharkov theory is given, and also the ion mobility in Fermi system is briefly discussed. (auth)

10346 (RM-2580(AEC)) FERMI-DIRAC AVERAGES OF THE FREE-FREE HYDROGENIC GAUNT FACTOR. J. M. Green (RAND Corp., Santa Monica, Calif.). June 30, 1960. 110p. Contract AT(29-1)-1477.

The effects of very high electron densities on the absorption of radiation by free-free electron transitions were studied. The absorption coefficient is expressed in terms of a dimensionless quantity known as the gaunt factor. The nonclassical effect of exclusion is accounted for by averaging the energy dependent hydrogenic gaunt factors of Latter and Karzas against the Fermi-Dirac electron distribution. Fermi-Dirac averages of the hydrogenic gaunt factor are tabulated over an appropriate range of thermodynamic states and photon energies. It is demonstrated that whenever the densities are high enough to require the use of the Fermi-Dirac averages, the effect of electron screening becomes important. It is shown how the Fermi-Dirac gaunt factor integrals may be altered to account for the effect of electron screening. (auth)

10347 REPRESENTATION OF SPACE INVERSION, TIME REVERSAL, AND PARTICLE CONJUGATION IN QUANTUM FIELD THEORY. F. A. Kaempffer (Univ. of British Columbia, Vancouver). Can. J. Phys., 39: 22-34 (Jan. 1961).

The unitary operators of space inversion and particle conjugation and the unitary factor of the antiunitary operator of time reversal can each be written in the form $e^{i\Omega}$, where Ω is the direct sum of two terms, $\Omega = \Omega_1\theta_1 + \Omega_2\theta_2$, with Ω_1, Ω_2, Hermitian bilinear forms in the creation and annihilation operators of the boson or fermion field under consideration and θ_1, θ_2 singular operators which separate the appropriate half spaces needed for the formulation of the symmetry operations. Explicit expressions are given for the generators Ω in case of a non-Hermitian boson field of spin 0, and in case of a four-component fermion field of spin $\frac{1}{2}$. (auth)

10348 MAXWELL'S EQUATIONS AND MATRIX ELEMENTS IN QUANTUM ELECTRODYNAMICS. H. A. Venables (Univ. of Alberta, Edmonton, Can.). Can. J. Phys., 39: 141-4(Jan. 1961).

Matrix elements of second-order processes in quantum electrodynamics are obtainable directly from the use of Maxwell's and Dirac's equations. (auth)

10349 RENDERING SAHA'S EQUATION MORE ACCURATE FOR THE CASE WHEN THE INTERACTION OF THE

IONS IS EXPRESSED BY "DISTANT" FORCES. Štefan Veis (Comenius Univ., Bratislova). Československ. časopis pro fysiku, 10: 398-403(1960). (In Czech.)

The equilibrium concentrations of ions of thermically ionized gas were investigated. If the interaction of the particles of the ionized gas was expressed in the form of "distant" forces, Saha's equation for the equilibrium concentrations of ions was obtained. The Saha's equation was derived for the influence of the interaction of the ions. It is more general than the Saha's equation derived by B. L. Timan, who expressed the interaction of the ions as a purely Coulomb equation. (auth)

10350 QUANTUM CORRECTIONS FOR TRANSPORT COEFFICIENTS. Sang-Il Choi and John Ross (Brown Univ., Providence, R. I.). J. Chem. Phys., 33: 1324-31(Nov. 1960).

The equation of motion of a quantum-mechanical two-particle system is solved without approximation in an expansion in Planck's constant. First-order quantum corrections comprising all contributions to the coefficient of $\hbar^2$ in the expansion are derived for the differential scattering cross section and the kinetic-theory transport coefficients. Numerical results are obtained for a simple model of molecular interactions, and lack of agreement is found with work based on the WKB solution of the Schrödinger equation. (auth)

10351 SYNTHETIC APPROACH AND CANONICAL VARIABLES IN A NONLOCAL FIELD THEORY. Smio Tani (Washington Univ., St. Louis). J. Math. Phys., 2: 46-51(Jan.-Feb. 1961).

The analysis of the axiomatic structure of quantum field theory establishes what is called the synthetic approach. The translation in time is completely defined by its transformation function; it defines also canonical variables. The hamiltonian is discussed at a later stage in order to establish the correspondence between this approach and the conventional one. An application is made to analyze Kristensen-Møller's theory of a nonlocal field. Its field variables are shown to be noncanonical; two field operators referring to two different points at the same time are not independent from each other when the distance between the two points is of the order of the extension of the form factor; however, this fact does not disturb the calculation of the S matrix. The situation is clearly understood when the Kristensen-Møller field operators are compared with the corresponding canonical variables. (auth)

10352 ON THE SCHRÖDINGER EIGENVALUE PROBLEM. [PART] II. Olavi Hellman (Nordisk Institut for Teoretisk Atomfysik, Copenhagen). Kgl. Danske Videnskab. Selskab, Mat.-fys. Medd., 32: No. 10, 1-15(1960). (In English)

The Schrödinger eigenvalue problem was reduced to the formation of a series whose terms were obtained by a simple process in which the main operation is integration. The formulas contain the potential $V_0(r)$ as such. The eigenvalues appear as roots of rapidly converging power series. The eigenfunctions are expressed in terms of functions obtained in the process of forming the said power series. The method is applicable also to the case where the mass is a function of r. (auth)

10353 STABILITY CONDITIONS AND NUCLEAR ROTATIONS IN THE HARTREE-FOCK THEORY. D. J. Thouless (Univ. of Birmingham, Eng.). Nuclear Phys., 21: 225-32(Nov. 5, 1960). (In English)

An expression for a general Slater determinant is written in the notation of second quantization. This expression has just the right number of arbitrary coefficients, so no subsidiary conditions are required, and the expression for a particular determinant is unique. This notation is used to study two problems. First, a condition for a particular solution of the Hartree-Fock equations to minimize the expectation value of the Hamiltonian is derived. This condition is equivalent to the condition for stability of collective modes in the random phase approximation. Second, the determinant which minimizes the expectation value of the Hamiltonian while giving a particular value to the expectation value of a component of angular momentum is found. In this way an expression for the moment of inertia of an axially symmetric system is derived within the framework of the Hartree-Fock theory. The expression for a determinant is generalized to include the type of wave functions used in the theory of superconductivity. (auth)

10354 ASYMPTOTIC CONDITIONS IN QUANTUM ELECTRODYNAMICS. L. E. Evans and T. Fulton (Johns Hopkins Univ., Baltimore). Nuclear Phys., 21: 492-507 (Dec. (1) 1960). (In English)

The applicability to quantum electrodynamics of the asymptotic condition of Lehmann, Symanzik, and Zimmerman (LSZ) is considered. The Coulomb gage formulation of the theory was examined and it is shown that the LSZ formalism can be used with this form, but not with the Lorentz gage form. Formal aspects of the renormalization program in the Coulomb gage are discussed. It is found that the renormalization of the electron requires momentum-dependent factors, and hence that the renormalized electron field violates local commutativity. The S-matrix is briefly discussed. To illustrate charge renormalization, a calculation of the charge of the state of a single electron is given. (auth)

10355 EIGENVALUES OF DENSITY MATRICES. B. C. Carlson and Joseph M. Keller (Ames Lab., Ames, Iowa). Phys. Rev., 121: 659-61(Feb. 1, 1961). (IS-176)

For a system of N identical particles in a pure bound state, the density matrices of positive orders p and N-p have the same nonzero eigenvalues with the same multiplicities. If the number of nonzero eigenvalues is finite, these density matrices are unitarily equivalent. (auth)

10356 STOCHASTIC DYNAMICS OF QUANTUM-MECHANICAL SYSTEMS. E. C. G. Sudarshan (Univ. of Rochester, N. Y.), P. M. Mathews, and Jayaseetha Rau. Phys. Rev., 121: 920-4(Feb. 1, 1961).

The most general dynamical law for a quantum mechanical system with a finite number of levels was formulated. A fundamental role was played by the so-called "dynamical matrix" whose properties are stated in a sequence of theorems. A necessary and sufficient criterion for distinguishing dynamical matrices corresponding to a hamiltonian time-dependence was formulated. The non-hamiltonian case is discussed in detail, and the application to paramagnetic relaxation is outlined. (auth)

10357 RELATIVISTIC FORMULA FOR THE SPIN CORRELATION COEFFICIENT C_{KP}. D. W. L. Sprung (Univ. of Birmingham, Eng.). Phys. Rev., 121: 925-6 (Feb. 1, 1961).

A formula due to Stapp for the spin correlation coefficient C_{KP} in nucleon-nucleon scattering is corrected. Formulas for the other triple-scattering and unpolarized-incident-beam correlation parameters are included. The formulas are applicable when the nonrelativistic scattering matrix formalism of Wolfenstein is used to analyze triple-scattering experiments at higher energies where relativistic effects are not negligible. The definition of

the correlation coefficients in the relativistic case is discussed. (auth)

10358 THE DENSITY MATRIX IN MANY-ELECTRON QUANTUM MECHANICS. II. SEPARATION OF SPACE AND SPIN VARIABLES; SPIN COUPLING PROBLEMS. R. McWeeny and Y. Mizuno (University Coll., North Staffordshire, Eng.). Proc. Roy. Soc. (London) A, 259: 554-7 (Jan. 24, 1961).

The spin-independent properties of an electronic system are completely determined by spinless density functions, $P_1(1; 1')$ and $P_2(1,2; 1',2')$, derived from the 1- and 2-electron density matrices, $\rho_1(1; 1')$ and $\rho_2(1,2; 1',2')$. These functions and their physical interpretation are considered. The generalizations that are necessary when the Hamiltonian contains spin terms (as in discussions of electron and nuclear spin resonances) are given. The density matrices and, more generally, the transition density matrices $\rho_1(\kappa\lambda|1; 1')$ and $\rho_2(\kappa\lambda|1,2; 1',2')$ associated with states Φ_κ and Φ_λ are resolved into spinless components associated with different spin situations: ρ_1 has four such components (one giving the density of α-spin electrons; a second, the density of β-spin electrons; and two with less direct physical significance), whereas ρ_2 has sixteen components. It is shown that all components for states $\kappa = (S,M)$, $\lambda = (S',M')$ of given S,S' are determined by three 2-electron functions. For $\kappa = \lambda$ these reduce to P_2, the spinless pair function, from which the electron density P_1 may be derived by integration; Q_2, a conditional spin density, from which the (1-electron) spin density Q_1 may be derived (as in the case of P_1 and P_2); and $Q_{c.a.}$, a coupling anisotropy function which describes the anisotropy of spin-spin coupling associated with quantization of the spin z-component. It is also useful to introduce (though it is not an independent function) Q_c, a coupling density function, which measures the coupling between the spins of two electrons at different points in space. All spin-dependent effects, including the usual spin-spin and spin-orbit couplings and (indirect) nuclear and electron-nuclear spin-spin couplings, may be related to the many-electron wave function through the above density functions. All the densities have a physical interpretation, independent of the precise nature of the wave functions (which may, for example, be the exact eigenfunctions of a spinless Hamiltonian or merely approximations of orbital form). The derivation of the density functions from approximate wave functions is considered in some detail. For functions describing weakly coupled electron groups (e.g., inner-shell and valence electrons) the densities may be expressed in terms of those of the separate groups. This reduction may be followed by an orbital description of each group and subsequently by a linear-combination-of-atomic-orbitals (l.c.a.o.) approximation. In the simpler approximations, all the coupling effects discussed are determined by electron and spin populations. Preliminary calculations suggest that such approximations may in many cases be adequate. (auth)

10359 APPROXIMATE METHODS IN THE QUANTUM THEORY OF MANY-FERMION SYSTEMS. R. K. Nesbet (Boston Univ.). Revs. Modern Phys., 33: 28-36(Jan. 1961).

The Hartree-Fock approximation for many-fermion systems is considered from two points of view, the solution of many-particle Schrodinger equation and the superposition of wave amplitudes. The integro-differential equations satisfied by Hartree-Fock orbitals are derived. Collective motion or particle correlation effects are discussed in connection with the unrestricted Hartree-Fock method. The relation between various generalizations of the method is discussed. (D.L.C.)

10360 CLASSICAL ELECTRODYNAMIC EQUATIONS OF MOTION WITH RADIATIVE REACTION. Gilbert N. Plass (Aeronutronic, New Port Beach, Calif.). Revs. Modern Phys., 33: 37-62(Jan. 1961).

The current status of classical description of radiating bodies is summarized, and classical equations of motion are presented for the motion of charged bodies. The general physical solutions for the case of force as an explicit function of time and the exact solutions for many different force fields are given for relativistic, nonrelativistic, one-dimensional, and three-dimensional motion. It is concluded that these equations provide an exact classical description of a radiating body. (D.L.C.)

10361 GEOMETRODYNAMICS AND THE PROBLEM OF MOTION. John A. Wheeler (Princeton Univ., N. J.). Revs. Modern Phys., 33: 63-78(Jan. 1961).

The problem of the motion of mass-energy is discussed within the context of geometrodynamics. Two models of mass are considered: Schwarzschild-like concentrations of mass-energy and geons. Criteria are given for the reanalysis of the problem of motion. (D.L.C.)

10362 SOME PROPERTIES OF DRESSED PARTICLE OPERATORS IN FIELD THEORY. M. A. Braun and Yu. V. Novozhilov (Leningrad State Univ., U.S.S.R.). Zhur. Eksptl'. i Teoret. Fiz., 39: 1317-22(Nov. 1960). (In Russian)

The operators are defined which yield single particle states upon acting on the vacuum. It is shown that along with the existence of a strong limit as the time tends to infinity for the "dressed" particle creation operators (which has been proved by Haag), the strong limit also exists for the annihilation operators. Assuming that the expansion in the coupling constant is possible, it is proved that the dressed operators cannot satisfy the causality conditions in their usual form. (auth)

10363 RADIATION FROM A CHARGE MOVING IN AN INHOMOGENEOUS MEDIUM. S. P. Kapitsa (Inst. of Problems in Physics, Academy of Sciences, USSR). Zhur. Eksptl'. i Teoret. Fiz., 39: 1367-70(Nov. 1960). (In Russian)

The radiation emitted by a charge moving uniformly in a medium with random inhomogeneities is considered. Expressions are derived for the intensity, polarization, and direction of the radiation. With approach to the threshold of the Cherenkov effect the intensity of the radiation was found to grow logarithmically. (auth)

10364 THE POSSIBILITY OF EXPERIMENTAL VERIFICATION OF THE NONAXIAL ROTATOR MODEL BY STUDYING THE EFFECT OF THE MEDIUM ON THE ANGULAR CORRELATION OF A GAMMA QUANTUM CASCADE. D. P. Grechukhin. Zhur. Eksptl'. i Teoret. Fiz., 39: 1371-3(Nov. 1960). (In Russian)

An experiment is proposed for checking the assumptions underlying the nonaxial rotator model for even-even nuclei. The experiment is based on measurement of the attenuation factor of the γ-quantum angular correlation for similar cascades in isotopes of the same element located in identical media. (auth)

10365 RELATIVISTIC ELECTRON THEORY. M. E. Rose. New York, John Wiley & Sons, Inc., 1961. 313p. $9.50.

A comprehensive treatment is presented of the Dirac single-particle description of relativistic quantum mechanics. The particles treated are spin-$\frac{1}{2}$ particles (fermions), which are lighter than nucleons; mesons(μ), neutrinos, and their antiparticles are included as well as electrons. (D.L.C.)

REACTOR TECHNOLOGY

General and Miscellaneous

10366 (AE-7) SPATIAL VARIATIONS OF THE ISOTOPIC CONCENTRATIONS IN A FUEL ROD. P-E. Ahlström and P. Weissglas (Aktiebolaget Atomenergi, Stockholm). 1960. 9p.

Formulas for taking account of nonuniform isotopic concentrations in a fuel rod are developed. A weight factor is introduced giving the effective concentration to be used in reactivity calculations. (auth)

10367 (AE-27) ON THE CALCULATION OF THE FAST FISSION FACTOR. B. Almgren (Aktiebolaget Atomenergi, Stockholm). November 1960. 23p.

Definitions of the fast fission factor ϵ are discussed. Different methods of calculation of ϵ are compared. Group constants for one-, two-, and three-group calculations were evaluated using the best obtainable basic data. The effects of back-scattering, coupling, and (n,2n)-reactions are discussed. (auth)

10368 (ANL-6218) CALCULATION OF HETEROGENEITY EFFECTS IN ZPR-III FAST ASSEMBLIES USING THE DSN PROGRAM. D. Meneghetti and M. F. Loomis (Argonne National Lab., Ill.). November 1960. 33p. Contract W-31-109-eng-38.

Reactivity changes, flux variations, and detector-response variations for ZPR-III fast critical assemblies, due to variations in heterogeneities caused by various intradrawer configurations of fuel and diluent plates and deviations of reactivities from ideal homogeneous cores, are calculated as reflective boundary slab cells using the DSN code. For these cells the calculated multiplication constants, for a given assembly plate configuration, by N = 4, 8, and 16 approximations successively increase such that the eigenvalues obtainable at N = 16 are still generally far from the limiting values at large N. This aspect makes for uncertainty, especially if differences in k_{eff} values from homogeneous are desired. (auth)

10369 (ANL-6295) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT [FOR] DECEMBER 1960. (Argonne National Lab., Ill.). Jan. 16, 1960. 68p. Contract W-31-109-eng-38.

Research and development are reported on the following reactors: water-cooled, EBWR, BORAX-V, sodium-cooled, EBR-1, and EBR-II. General studies were also made on nuclear superheating, reactor safety, and nuclear technology. (For preceding period see ANL-6269.) (W.L.H.)

10370 (BAW-1209) HEAVY WATER REACTORS AND THE PROPERTIES, ANALYSIS, HANDLING, AND EFFECTS OF HEAVY WATER. A BIBLIOGRAPHY. Dorothy M. Duke (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). December 1960. 54p. Contract AT(30-1)-2602.

This bibliography includes 523 references from the report and published literature on heavy water and heavy-water reactors. The following sources were scanned: Abstracts of Classified Reports, 1956 to date; Applied Science and Technology, 1957 to date; Chemical Abstracts, 1956-1957; Engineering Index, 1957 to date; and Nuclear Science Abstracts, 1957 to date. A subject index is included. (L.T.W.)

10371 (CF-59-6-89) INTERNALLY COOLED MOLTEN-SALT REACTORS. M. E. Lackey (Oak Ridge National Lab., Tenn.). June 22, 1959. 15p.

The initial and long-term nuclear characteristics of two internally cooled heterogeneous graphite-moderated two-region molten-salt reactors were studied. The reactors have doubling times of 22.5 and 27.5 years. Methods of decreasing the doubling times by removing the Pa^{233} from the core and by increasing the specific power of the reactor are described. (auth)

10372 (CF-59-9-52) CONTAINMENT VESSEL COST AND BUCKLING CONSIDERATIONS. G. C. Robinson (Oak Ridge National Lab., Tenn.). Sept. 15, 1959. 18p.

The economics of various types of reactor containment is discussed. Curves suitable for feasibility cost estimates are presented for spherical and cylindrical pressure vessels. Approximate limitations on cylindrical pressure-vessel height imposed by buckling considerations for snow, wind, and vessel weight loads are also given. (auth)

10373 (CF-59-12-91) UO_2 FUEL CLUSTER STUDY. J. G. Delene and T. H. Row (Oak Ridge National Lab., Tenn.). Dec. 31, 1959. 38p.

The reactor physics aspects of a number of different UO_2 cluster geometries were determined as a function of various parameters. These parameters included number of rods in cluster, cladding material, cladding thickness, cored and uncored rods, lattice pitch, rod size, and inter-rod spacing. Lifetime calculations were made on the basis of batch loading and uniform exposure for 5000 and 7500 Mwd/Mt-UO_2. (auth)

10374 (CF-60-1-75) PRESSURE VESSEL EXPOSURE TO FAST NEUTRONS. R. S. Carlsmith (Oak Ridge National Lab., Tenn.). Jan. 21, 1960. 8p.

It is suggested that a reduction in pressure vessel diameter could be achieved by substituting a thin layer of lithium hydroxide for the outer portion of the reflector. It is effective in reducing the fast flux through the high slowing-down power of the hydrogen and also of the lithium and oxygen. In order to determine the effectiveness of lithium hydroxide, a series of multigroup calculations was made using Oracle Cornpone Code. (W.L.H.)

10375 (CF-60-10-102) A STUDY OF URANIUM ISOTOPIC RATIO INFORMATION FROM THE HRT. H. B. Piper, S. R. Buxton, and P. N. Haubenreich (Oak Ridge National Lab., Tenn.). Oct. 27, 1960. 18p.

Samples taken at low power ("no loss" conditions) over a period from Run 12 to Run 21 were analyzed by mass spectrograph to determine uranium isotopic composition. Results confirmed that part of the uranium inventory is at all times held up, out of solution, in the reactor and that there is limited isotopic exchange between dissolved uranium and uranium in solids. (auth)

10376 (GAMD-224) CHEMICAL PROBLEMS IN THE USE OF A UC_2-ThC_2-C CORE IN THE HOMOGENEOUS REACTOR. A. W. Searcy (General Atomics Div., General Dynamics Corp., San Diego, Calif.). Oct. 3, 1957. 14p. Contract AT(04-3)-314.

From a chemical point of view, the ideal fuel and moderator mixture should be thermodynamically stable and nonvolatile under the conditions of use. Neglecting behavior of fission products, a UC_2-ThC_2 solid solution surrounded by graphite would appear to meet these criteria. The equilibrium solubility of uranium and thorium in graphite, stability of UC_2 and ThC_2, diffusion of UC_2 into graphite, implications to homogeneous reactor design, and suggested experiments are discussed. (W.D.M.)

10377 (GAMD-1439) CELL AND CORE NEUTRON CALCULATIONS PERFORMED WITH THE ONE-DIMENSIONAL TRANSPORT CODE, DSN, WITH REFERENCE TO

THE HTGR CRITICAL ASSEMBLY. H. Fenech and N. F. Wikner (General Atomics Div., General Dynamics Corp., San Diego, Calif.). June 8, 1960. 52p. Contract AT(04-3)-314.

The effect of the spatial dependence of the energy spectrum (fast and thermal) and of the flux angular distribution on k_{eff} and its temperature dependence was evaluated for a reactive assembly. A series of criticality calculations was performed for the HTGR assembly using the DSN code with the S_2, S_4, S_6, S_8, and S_{16} approximations and 1, 2, 6, and 18 thermal groups with three fast groups. Results for slab geometry are given. (W.D.M.)

10378 (HW-62806) DECONTAMINATION STUDIES FOR HAPO HIGH TEMPERATURE REACTOR RECIRCULATION SYSTEMS. PROGRESS REPORT: JUNE 1959 TO JANUARY 1960. T. F. Demmitt, G. E. Neibaur, L. D. Perrigo, and R. D. Weed (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 28, 1960. 69p. Contract AT(45-1)-1350.

Investigations are continuing to determine the effectiveness and corrosion characteristics of several prospective decontamination processes for high-temperature recirculating-water-cooled nuclear reactor systems. Types of contamination encountered in nuclear reactors include fission products and uranium dioxide from ruptured fuel elements and activated corrosion product films on piping surfaces. Acidic solutions preceded by a highly alkaline, potassium permanganate solution usually remove the corrosion product contamination, but this procedure is not effective in removing uranium dioxide and fission products associated with fuel-element ruptures. A solution of hydrogen peroxide, sodium carbonate, and sodium bicarbonate plus wetting and stabilizing agents was developed. This solution is highly effective in removing these materials. Acidic solutions evaluated during corrosion-product removal studies include sodium bisulfate, ammonium citrate, oxalic acid, phosphoric acid, and nitric acid. (For preceding period, see USAEC Report HW-60677.) (auth)

10379 (IEA-9) A REAÇÃO $Be^9(n,2n)Be^8$ EM REATORES TÉRMICOS HETEROGÊNEOS MODERADOS A BERÍLIO: II. CÁLCULO DO FATOR DE EFEITO RÁPIDO. (The Reaction $Be^9(n,2n)Be^8$ in Heterogeneous, Thermal Reactors Moderated with Beryllium: II. Calculation of the Fast Effect Factor). Darcy Dillenburg, Gerhard Jacob, and E. P. Saraiva De Toledo (Brazil. Instituto De Energia Atômica, São Paulo). 1960. 13p.

Using the theoretical basis established in part one, an estimate was made of the fast effect in beryllium on the infinite multiplication factor of heterogeneous thermal reactors moderated by beryllium. Using available data relative to the different collision cross sections involved, the result obtained was a 7% increase in the multiplication factor. This value is in agreement with data previously presented at the Geneva Conference, and approximates the results of criticality experiments. (tr-auth)

10380 (JPL-TR-32-40) MULTIGROUP DIFFUSION WITH PERIODIC ARRAYS OF LINE SOURCES. Frank B. Estabrook (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Nov. 9, 1960. 19p. Contract NASw-6.

A multigroup diffusion theory is formulated for heterogeneous reactors having periodic arrays of line discontinuities. These discontinuities are idealized cylindrical internal boundaries of an otherwise homogeneous moderating medium, and appropriate mixed-group or multiplying boundary conditions at such boundaries allow Floquet solutions to be found for the neutron fluxes in the moderator. Real superpositions of such Floquet solutions then can give the physical fluxes in finite reactors. The requirement that a Floquet solution in the moderator have the proper thermal flux behavior at a cylindrical internal boundary, to match the thermal flux actually inside a fuel rod, leads to a " criticality" condition, the solutions to which give the spectrum of allowed Floquet solutions. For each of these a relation between material bucklings B_x^2, B_y^2, and B_z^2 is obtained which is, in general, anisotropic. Some approximations to the general theory are given, and it is shown in the two-group case that the theory properly reduces to the homogeneous approximation. (auth)

10381 (NAA-SR-5251) POWER FLATTENING IN OMR CORES. G. K. Gardiner (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1960. 39p. Contract AT(11-1)-GEN-8.

Methods of improving the nuclear and thermal performance of a power reactor by flattening the radial power distribution throughout core life are examined and partially evaluated. The methods consist of varying the initial fuel enrichment and/or initial moderator to fuel ratio in various parts of the core to decrease the peak-to-average radial power ratio. The analysis was performed on a cylindrical organic-moderated and -cooled reactor, fueled with slightly enriched uranium alloy plates clad in aluminum. The study was directed toward methods of flattening the radial power distribution by radial variation in fuel enrichment or moderator to fuel ratio. The effect of burn-up and control rods on the improved power distribution was examined. The burn-up study was limited to a batch type analysis; i.e., it was assumed that no fuel rotation would take place during the lifetime of the initial core. (auth)

10382 (NAA-SR-5417) KINETIC EXPERIMENTS ON WATER BOILERS-"A" CORE REPORT. PART III—PILE OSCILLATOR RESULTS. R. N. Cordy (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1960. 54p. Contract AT(11-1)-GEN-8.

A brief review of the theoretical water-boiler reactor-power transfer function is presented as background for the experimental determination of the ratio of effective prompt neutron lifetime to the effective fraction of delayed neutrons, $1/\beta$. The preparation and performance of the experiment are discussed with special emphasis on equipment, procedures, and measurement errors. The results, which strongly support a seven-delay-group model of the reactor, are presented and compared with theoretical six- and seven-group models. The experiment indicates qualitative values of the seventh-group constants, and it also indicates an $1/\beta = 7.7 \pm 0.3$ msec valid for all but short-period transients. (auth)

10383 (NAA-SR-Memo-5137) LEAKAGE CHARACTERISTICS OF OPENINGS FOR REACTOR HOUSING COMPONENTS. L. Baurmash, F. C. Burnett, R. L. Koontz, and C. T. Nelson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 20, 1960. 44p. Contract AT(11-1)-GEN-8.

Measurements were made of the air leakage rates through structural components that penetrate semicontainment reactor housing installations. Full-sized test specimens were sealed inside a 10-ft-diameter test sphere, and the leakage rate was measured as a function of pressure for pressure differentials of up to 25 in. of water. The data were fitted to empirical equations that describe the leak rate at any pressure differential within the range of the experimental tests. The forms of the equations are such that the total leak rate of a building can be obtained by summing the empirical constants and multiplying by a probable pressure differential. (auth)

10384 (NAA-SR-Memo-5337) PROCEDURES FOR LOW-POWER PHYSICS EXPERIMENTS IN THE SRE. S. F. Burton, C. W. Griffin, R. W. Keaten, R. A. Lewis, R. A. Moser, and R. W. Woodruff, eds. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 1, 1960. 240p.

A compilation of the procedures for the low-power physics experiments to be performed with the SRE second fuel loading is presented. Reactor power will remain below 120 kw. Critical mass, shim rod worths, statistical weights, isothermal temperature coefficient, and reactor transfer function will be measured. (W.D.M.)

10385 (NAA-SR-Memo-5597) METHODS OF MEASURING VOID FRACTIONS. S. W. Gouse (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 29, 1960. 41p.

A literature survey of methods of void-fraction measurement was accomplished, and the results are summarized in tabular form. A detailed uncertainty analysis of the proposed γ or x-ray attenuation technique was performed. A method for choosing a system sensitivity for minimum over-all uncertainty is presented. (W.D.M.)

10386 (NAA-SR-Memo-5679) CALCULATION OF THE FAST EFFECT FOR VARIOUS URANIUM FUEL ELEMENTS. F. L. Fillmore and D. R. Anderson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 26, 1960. 11p.

As a part of a program to improve the methods for doing lattice calculations, the fast effect (ϵ) and the U^{238}-to-U^{235} fission ratio (R) for various fuel elements were calculated, using different methods and cross-section data. Some of the geometrical approximations used in calculating the collision probability (P) for fuel elements consisting of clusters of rods were also calculated. (W.L.H.)

10387 (NAA-SR-Memo-5812) CRITICALITY CALCULATION. R. A. Blaine (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 24, 1960. 5p.

Critical loadings were calculated for the Organic Moderated Reactor Critical Assembly 5.5- and 6-in. uniform lattices. (W.D.M.)

10388 (NAA-SR-Memo-5817) RADIOLOGICAL IMPLICATIONS CONCERNING THE USE OF ARGON AS THE CORE COVER GAS IN SODIUM GRAPHITE REACTORS. R. S. Hart (Atomics International. Div. of North American Aviation Inc., Canoga Park, Calif.). Oct. 24, 1960. 8p.

The substitution of argon for helium as the inert core cover gas in sodium graphite reactors would result in an economic advantage in most areas of the world. The actual amount of extra radioactivity which would occur is calculated, and the radiological significance of this activity is evaluated with reference to existing design and operating characteristics of sodium graphite reactors. (W.D.M.)

10389 (NDA-2131-20) A METHOD FOR CALCULATING THE REACTIVITY OF SIMPLE D_2O-MODERATED NATURAL URANIUM LATTICES. J. Agresta, W. L. Brooks, J. H. Ray, H. Soodak, D. Spielberg, and N. Tralli (Nuclear Development Associates, Inc., White Plains, N. Y.). Sept. 30, 1960. 77p. Contract AT(30-1)2303 (1X).

A consistent set of definitions for ϵ, p, η, f, τ, and L^2 was formulated, and the material buckling was calculated from $k_\infty = \epsilon p \eta f = \epsilon^{\tau B^2}(1 + L^2 B_m^2)$. In calculating each factor, the cell method was used with a reflecting boundary condition. (W.D.M.)

10390 (RAG-13) THE EFFECT OF LATTICE PERTURBATIONS ON CRITICALITY. T. Auerbach (Reaktor A. G., Wurenlengen, Switzerland). March 1960. 31p.

A method is developed for treating perturbations in a finite lattice arising from the removal or insertion of fuel rods. The lattice is divided into two regions, an inner heterogeneous one and an outer one, in which fuel and moderator are homogenized. In the heterogeneous region the diffusion equation is solved by Feinberg's method both for the unperturbed and the perturbed lattice. A critical η is found in both cases by matching the solutions in the two regions along a common boundary. (auth)

10391 (TID-6902) REACTIVITY MEASUREMENTS IN THE PRESENCE OF A SPURIOUS NEUTRON SOURCE. J. F. Kunze, K. J. Skow, and R. M. Kinkaid (General Electric Co. Aircraft Nuclear Propulsion Dept., Idaho Falls, Idaho). June 8, 1960. 24p. (DC-60-6-721)

The long-lived core gamma activity and the resulting photoneutrons from beryllium have been found to significantly affect the measurements of reactivity by the reactor period method with a core reflected by beryllium. A method of correcting for the effects of such a spurious neutron source has been employed. The resulting reactivity measurements were consistent and reproducible to within ±0.5%. Relative reactivity determinations were made with the same accuracy, with periods that varied between 20 and 1000 sec. The absolute value of the reactivity is still subject to the uncertainties in the in-hour equation parameters. (auth)

10392 (WCAP-1423) MULTI-REGION REACTOR LATTICE STUDIES. Quarterly Progress Report [for the period] July 1 to September 30, 1960. Ira H. Coen (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Oct. 28, 1960. 53p. Contract AT(30-1)-2176.

Critical Experiments. After reports of fuel-element and control-rod fabrication progress, the critical experiments performed are outlined. These experiments included measurements on a 3.7% core, criticality measurements on a three-region core, peripheral fuel rod worth for a three-region core, fuel-rod and foil scans in a three-region core, multiple foil measuring techniques, analysis of errors in U^{238} Cd ratio measurements, and comparison of 3.7 and 2.7% cores. Nuclear Analysis of Multi-region Reactor Cores. Work continued on calculations of lattice parameters, comparison of results with experiment, and evaluation of methods of analysis. (For preceding period see WCAP-1419.) (T.R.H.)

10393 (WCAP-1695) THERMOELECTRIC NUCLEAR FUEL ELEMENT, QUARTERLY PROGRESS REPORT FOR OCTOBER–DECEMBER 1960. G. R. Kilp, W. P. Blankenship, K. J. Gill, R. C. Goodspeed, P. V. Mitchell, and E. G. Schwartz (Westinghouse Electric Corp., Atomic Power Dept., Pittsburgh). Jan. 10, 1961. 63p. Contract AT (30-3)-500.

Materials prepared for evaluation of thermoelectric properties included PbTe, USe, and USTe. The life test of hot-swaged PbTe has exceeded 4300 hr. Thermal-conductivity values were obtained for a Lavite sample. A swaged PbTe couple featuring dual doping levels of the thermoelectric materials for thermal cascading was tested. An operating efficiency of 5.36% was achieved with a PbTe element featuring a major decrease in clad resistance. A metallographic study of swaging of PbTe is presented. Latest data on compatibility of thermoelectric materials with cladding materials indicate that W, Al, and, possibly, Cr are the most nearly compatible materials tested with

$Ge_xBi_{1-x}Te$. Design considerations are listed for a thermoelectric fuel element in which the hot junction temperature is a constant value independent of reactor power distribution. (auth)

10394 (XDC-60-6-134) MULTIGROUP CALCULATION OF THERMAL NEUTRON SPECTRA IN HYDRIDED ZIRCONIUM MEDIA WITH INCLUSION OF ACOUSTICAL AND OPTICAL SCATTERING MODES. D. E. Wetzel (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). June 8, 1960. Decl. Aug. 12, 1960. 19p. Contracts AF33 (600)-38062 and AT(11-1)-171.

The results are given of an investigation of the feasibility of direct calculation of thermal-flux distribution employing multigroup theory. Experimental spectral data for pure hydrided zirconium ($ZrH_{1.8}$) are correlated satisfactorily by a calculational procedure that accounts for chemical binding of the hydrogen by using the Fermi pseudopotential theory. The hydrogen is allowed to exchange energy with neutrons in discrete amounts, as well as by acoustical mode scattering, in multiples of $h\mu$ (= 0.130 ev). The thermal energy range (i.e., 10^{-4} to 10 ev) is arbitrarily divided into nine energy groups, and cross section and transfer data are generated for each group. The data are incorporated in a multienergy multiregion single-space-dimension neutron-diffusion theory calculation of the thermal-flux distribution in an infinite slab of hydrided zirconium at 80.6 and 1000°F. (auth)

10395 RELEASE OF γ ENERGY BY THE PRODUCTS OF THE THERMAL FISSION OF U^{235} IN THE CASE OF PERIODIC FUNCTIONING OF A NUCLEAR REACTOR. T. Toşescu. Acad. rep. populare Romîne, Inst. fiz. atomică şi Inst. fiz., Studii cercetări fiz., 11: 501-13(1960). (In Romanian)

The release of γ energy by the products of the thermal fission of U^{235} after the shutdown of the reactor was calculated for the case where the reactor operates periodically. The calculations were made, for each radioactive series of fission products, by utilizing the general equations of radioactive disintegrations. These results are compared with those which, up to the present, have been obtained only by the semi-empirical formulas of Way and Wigner. (tr-auth)

10396 GLOBAL ASYMPTOTIC STABILITY FOR NONLINEAR SYSTEMS OF DIFFERENTIAL EQUATIONS AND APPLICATIONS TO REACTOR DYNAMICS. J. J. Levin and J. A. Nohel (Massachusetts Inst. of Tech., Cambridge and Georgia Inst. of Tech., Atlanta). Arch. Rational Mech. and Anal., 5: 194-211(1960).

Conditions were obtained under which all solutions of certain real nonlinear systems of differential equations tend to zero as $t \to \infty$. This global asymptotic stability was derived from five theorems, including modifications of the Lienard equation and the Liapounov ordinary stability theorem. Applications of the results to certain problems in reactor dynamics are discussed. (M.C.G.)

10397 DATA HANDLING IN POWER STATIONS. C. Ayers (English Electric Co. Ltd., [London]). Brit. Power Eng., 2: 50-4(Jan. 1961).

Increasing complexity of power stations has led to changes in control-room design for better data sampling, transmission, and analysis. Control-room equipment and use are discussed. (T.R.H.)

10398 STEAM-VOIDS COEFFICIENT OF THE REACTIVITY IN NUCLEAR REACTORS. Nejat Aybers (Technical Univ., Istanbul). Bull. Tech. Univ. Istanbul, 13: 45-64(1960). (In English)

A process for determining the change in reactivity with steam-void formation in nuclear reactors is discussed. An analytical procedure is presented for evaluating the fractional change in reactivity ($\delta k_{eff}/k_{eff}$) per fractional increase in core moderator volume ($\delta V/V_m$). The differential perturbations in the reactor constants due to steam-void formation throughout the reactor were evaluated, the flux densities and their adjoints for a reflected cylindrical reactor and a two-group model were determined, and the integrands in the perturbation formula for the change in reactivity were found to obtain a specific equation for the fractional void coefficient of the reactivity for a reflected cylindrical reactor core. (auth)

10399 MEASUREMENT OF REACTOR PARAMETERS. [PART] I. Lajos Bata (Central Physical Research Inst., Hungary). Energia és Atomtech., 13: 490-4 (1960). (In Hungarian)

Measurement of the slowing down length of fission neutrons in uranium–water systems is discussed, describing the experimental methods which include the use of a cadmium-clad U^{235} foil. For the determination of diffusion length, the poisoning and enrichment methods are considered. For evaluation of results, the one-group theory and the neutron age equation are referred to. (TTT)

10400 EFFICIENCY AND POTENTIAL USES OF SMALL, HEAT-GENERATING NUCLEAR REACTORS. PART II. Jozsef Halzl, László Retvári, and Miklós Torma. Energia és Atomtech., 13: 495-501 (1960). (In Hungarian)

The following factors affecting the efficiency of the heat supplied by small reactors are reviewed: degree of utilization of the plant, demand, peak loading, and the requirements of the various industries, such as paper and pulp, oil refining, fertilizers, pharmaceuticals, rubber manufacturing, textiles, leather, and ceramics. The quality of the steam supplied depends greatly on the demand of the industries, for example, sugar and plastics industries need only low-pressure low-temperature steam while many others require high-pressure steam. The population density also affects the economical consideration: its demand is important but geological, hydrological, and meteorological questions become decisive in this case. Among the foreign projects, the planned Swedish and Norwegian stations are described. It is mentioned that after having concentrated her efforts on large gas-cooled systems, England has recognized the advantages of the small pressurized-water reactors for supplying heat. The various U. S. projects are also described, pointing out that despite the low fossil fuel costs, nuclear heat is on the verge of becoming competitive; in addition, it offers the opportunity to export small plants to European countries. (TTT)

10401 DROP TIME MEASUREMENT APPARATUS OF NUCLEAR REACTOR SAFETY RODS. S. Barabaschi, G. Franco, and A. Pulacci (Centro Ricerche Nucleari, Ispra, Italy). Energia nucleare (Milan), 7: 792-6(Nov. 1960). (In English)

The measurement of drop time of reactor safety rods is usually quite difficult because of the lack of an adequate system to signal the instant at which a rod reaches its terminal position. An electronic instrument is described in the present paper which permits the measurement of the drop time of safety rods by a vibration pick-up. A prototype of the instrument has been used in the ISPRA-1 Reactor for more than a year with good results. (auth)

10402 METHODS FOR THE MEASUREMENT OF THE PHYSICAL PARAMETERS OF THE CORE OF HETEROGENEOUS REACTORS BY MEANS OF EXPONENTIAL EXPERIMENTS. III. S. Tassan (Brookhaven National Lab.,

Upton, N. Y.). Energia nucleare (Milan), 7: 821-32(Dec. 1960). (In Italian)

The macroscopic reactor core parameters determined by exponential experiments (buckling, reflector saving, relaxation length, and migration area) are reviewed. The most significant experimental results, some still unpublished, are compared with the correspondent theoretical values. (auth)

10403 HEAT EXTRACTION AND FUEL ELEMENTS IN AN ORGANIC REACTOR. L. Berardinelli, M. Guidotti, and G. C. Pinchera (Comitato Nazionale per le Ricerche Nucleari, Rome). Energia nucleare (Milan), 7: 833-42(Dec. 1960). (In Italian)

Some of the problems connected with heat extraction in organic-moderated and -cooled reactors are examined. In particular, the characteristics of the organic liquids related to heat-transfer limiting conditions and core configuration are investigated. Different types of fuel elements, such as unfinned plate, finned plate, unfinned rod, finned rod, and staggered pin elements, for use in organic reactors are also examined. The various elements are compared from different points of view, namely, heat-transfer capacity, pressure drop, and volumetric fraction of the fuel cladding material. (auth)

10404 CORROSION PROBLEMS OF HETEROGENEOUS NUCLEAR REACTORS. Vladimir Čihal and Ivan Sekerka. Hutnické listy, 14: 978-84(Nov. 1959). (In Czech.)

Corrosion problems in carbon dioxide and water-cooled reactors were investigated. The construction materials used most frequently for high-pressure carbon dioxide systems are magnesium, beryllium alloys, and alloy steels. Aluminum, nickel alloys, and Zircaloy were found to have sufficient water resistance at 300°C. The austenitic stainless steels were very resistant to corrosion at temperatures up to 360°C. (auth)

10405 THERMOELECTRIC CONVERSION WITH EMPHASIS FOR APPLICATIONS TO NUCLEAR REACTOR HEAT. Kurt Katz (Westinghouse Electric Corp., Pittsburgh). IRE Intern. Conv. Record, 8: Pt. 9, 47-53(1960).

Many advantages could be realized if it were possible to convert the heat energy produced in a reactor directly to electrical energy. The efficiency equations and the present status of materials for thermoelectric conversion by means of the Seebeck-Peltier effect are reviewed. Several schemes for converting fission-generated heat directly to electrical energy in the core zone of a reactor are described. An out-of-pile thermoelectric converter, that is one converting fission-generated heat external of the reactor core, involves less formidable problems and could be developed more quickly. However, due to a lower hot-junction temperature, its efficiency is lower. In-pile conversion is a future possibility. It is dependent upon the effect of irradiation upon thermoelectric materials, development of materials compatible with reactor environment (cross-section, etc.), and better high-temperature thermoelectric materials. One very attractive feature of in-pile conversion is that the fuel centerline temperature can be utilized as the hot junction, thus giving a high Carnot cycle efficiency. (auth)

10406 THERMIONIC CONVERTERS, NUCLEAR HEAT, AND POWER GENERATION. Walter Grattidge (General Electric Research Lab., Schenectady, N. Y.). IRE Intern. Conv. Record, 8: Pt. 9, 54-65(1960).

A thermionic converter is a static high-temperature engine converting heat to electricity. It is a vacuum- or gas-filled device containing a hot cathode and a cold anode. Properties and operating characteristics of typical types of converters are described. Nuclear energy such as produced in a power reactor is an ideal heat source for a thermionic converter. The converter cathode and nuclear fuel element can be designed as an integral unit with the anode cooled by a conventional reactor coolant. Thus the converter becomes an integral part of the fuel assembly. The anode temperature can be sufficiently high to permit waste heat to be used in a steam turbine cycle. The thermionic converter becomes a "topper" to the steam turbine and augments its performance. Some important problem areas are delineated. (auth)

10407 NOBLE GAS PLASMA DIODE THERMIONIC CONVERTER. Frank E. Jamerson (General Motors Research Labs., Warren, Mich.). IRE Intern. Conv. Record, 8: Pt. 9, 66-71(1960).

The direct conversion of nuclear heat to electricity is investigated in a plasma diode that utilizes fission fragments from a uranium-bearing cathode to produce a plasma in a noble gas. The fractional ionization is relatively low, but the electron mobility in a noble gas is relatively high so that a reasonable diode impedance might be attained. The advantage of such a diode converter is that it eliminates the need for an initial charge of alkali vapor as used in other plasma diodes. An experiment was performed in the University of Michigan reactor in which a diode containing argon with a uranium carbide cathode was operated up to a temperature of 2000°K. This experiment demonstrated that the noble gas plasma diode acts as an energy converter. Subsequent analysis indicated that some of the experimental parameters limited conversion efficiency. The present theory of the noble gas plasma diode is described in which plasma sheaths at cathode and anode boundary are shown to control the operating characteristic of the diode. Current is limited to the random electron current in the plasma near the anode. Calculations indicate that with a reasonable set of parameters power densities of order 5 watts/cm^2 might be achieved, which is in the range of practical interest. The possibility of a noble gas plasma diode converting to a cesium diode from the formation of cesium by the fission process is described. (auth)

10408 EXPERIMENTAL STUDY OF THE TEMPERATURE OVERSHOOT AND THE DELAY TIME OF THE TRANSIENT BOILING. Shigenori Hayashi, Tetsuo Iwazumi, Jiró Wakabayashi, Akira Sakurai, Hideto Aoki, and Motohiko Kitamura (Kyoto Univ.). J. Atomic Energy Soc. Japan, 2: 736-41(Dec. 1960). (In Japanese)

In order to study the transient nucleate boiling on the fuel plate surface of a light-water-cooled and -moderated reactor when a sudden large reactivity is given to it, a fundamental experiment was made by means of stepped electrical heating of metal foil located in stagnant water under atmospheric pressure. From these studies, it is understood that the temperature overshoot of the metal surface from the saturation temperature of water and the delay time between passage of saturation temperature and the beginning of boiling, may, regardless of the degree of subcooling, be predicted in terms of the temperature rising velocity of the metal surface. With these results, it is possible to make a precise analysis of the light-water-cooled and -moderated reactor kinetics in case of the power excursion. (auth)

10409 ON A SYSTEM OF INTEGRODIFFERENTIAL EQUATIONS OCCURRING IN REACTOR DYNAMICS. J. J. Levin and J. A. Nohel (Massachusetts Inst. of Tech., Lexington; Mathematics Research Center, Madison, Wis.; and

Georgia Inst. of Tech., Atlanta). J. Math. Mech., 9: 347-68(May 1960).

A study is made of the existence, uniqueness, and asymptotic behavior (as $t \to \infty$) of the solution of the real system $du/dt = -\int_{-\infty}^{\infty} \alpha(x)T(x,t)\,dx$, $a\,\partial T/\partial t = b\,\partial^2 T/\partial x^2 + \eta(x)u$ $(0 \leqq t < \infty)$, satisfying the initial condition $u(0) = u_0$, $T(x,0) = f(x)$ $(-\infty < x < \infty)$. The system describes the linearized dynamic model of a continuous-medium nuclear reactor, t = time, x = position along the reactor (regarded as a doubly infinite rod), u(t) = logarithm of total reactor power [u(t) ≡ 0 at equilibrium], T(x,t) = deviation of temperature from equilibrium [T(x,t) ≡ 0 at equilibrium], $-\alpha(x)$ = ratio of temperature coefficient of reactivity to the mean neutron life, $\eta(x)$ = fraction of power generated at x, a = heat capacity, and b = thermal conductivity. Of particular interest also is the degenerate system obtained by setting b = 0. (T.R.H.)

10410 RANDOM FLUCTUATIONS IN A NUCLEAR FISSION REACTOR. L. G. Kemeny and Samaun (Queen Mary Coll., London). Nature, 189: 130-1(Jan. 14, 1961).

Measurements were made of time-dependent reactor parameters, using a spectral analysis technique and the formulation of both theory and experiment for the correlation analysis and measurement of spatially dependent reactor parameters. Recordings were made of the time-trace of random fluctuations in neutron density in a reactor operating autonomously at low power. An amplitude spectrum and a spectral density curve were derived from the direct recording of this noise wave-form. Conclusions were drawn concerning the effective, prompt neutron lifetime in the reactor and the reactor transfer function. A block diagram of the recording apparatus and samples of the reactor-power random fluctuation recording are presented. (C.H.)

10411 PRINCIPAL FEATURES OF REACTOR SAFETY SYSTEMS. C. Zangger (Atomelectra Ltd., Zurich, Switzerland). Neue Tech. 2, No. 10/11, 53-7 (Oct.-Nov. 1960). (In English)

The most important features of safety systems of nuclear reactors are reviewed. The working principles of safety systems are described, as well as the abnormal conditions under which they become operative and the different kinds of operation they perform. Special attention is devoted to the consequences of the contradictory requirements of the safety and availability of the reactor plant. (auth)

10412 WASTE MANAGEMENT OF WATER-COOLED REACTOR PLANTS. P. J. Koenig and C. Zangger (Atomelectra Ltd., Zurich, Switzerland). Neue Tech. 2, No. 10/11, 57-68 (Oct.-Nov. 1960). (In English)

Apart from their main product (electricity) nuclear power plants produce in addition radioactive liquid, gaseous, and solid wastes of a wide variety. By "waste management" is meant the entire field of activity which is concerned with the different aspects of processing and disposing of these, be it in general or as applied to a specific situation. The principles of waste management are outlined with particular reference to water-cooled reactors. The origin and the characteristics of the different types of waste are examined on the basis of large-scale operating experience gained to date, and various processing and disposal techniques are reviewed. (auth)

10413 REACTOR CONTAINMENT. A. Sutter (Atomelectra Ltd., Zurich, Switzerland). Neue Tech. 2, No. 10/11, 69-76 (Oct.-Nov. 1960). (In English)

Whenever the possibility exists that a reactor accident could lead to a rupture of the primary circuit and the release of dangerous quantities of radioactive fission products to the environment, the total containment of the reactor and its cooling system within a gas-tight structure is called for. Beginning with the most serious types of accidents generally admitted, the various factors which determine whether containment is required are examined. A second part of the paper is concerned with the problems of containment, as applied to the various types of water-cooled reactors, considering both the effectiveness and integrity of such structures. Studies of the technical problems involved in the evaluation and construction of such containment structures are described. Finally, the merits and problems of the use of rock caverns as reactor containment are discussed and the general lines of additional work needed to complete this evaluation are indicated. (auth)

10414 NUCLEAR REACTORS IN UNIVERSITIES. N. S. Grassam. Nuclear Energy, 19-28, 32(Jan. 1961).

The construction and use of nuclear reactors at universities are discussed. The research potential and the opportunity provided for teaching experimental techniques used on reactors are described. The reactor designs and connected research programs at American universities are reviewed. Reactor power, siting, buildings, staff, health arrangements, and reactor utilization are discussed. An outline of the prospects of the university reactor program in the United Kingdom is presented. (M.C.G.)

10415 REACTORS IN THE SOVIET UNION. Vassily Emelyanov. Nuclear Power, 6: No. 58, 75-6(Feb. 1961).

A survey of the reactors recently constructed or being constructed in the Soviet bloc is given. In addition to the two operational nuclear power stations, four are being built: two in Russia [Beloyarsk, 285 Mw(t) and Voronezh, 760 Mw(t)], one in Czechoslovakia [590 Mw(t)], and one in East Germany [265 Mw(t)], and their characteristics are given. The reactors in the Lenin icebreaker are described. Finally, other reactor types, e.g., research, fast, etc., are discussed. (D.L.C.)

10416 SOLUTION OF REACTOR DYNAMIC EQUATIONS. W. A. Havranek and T. M. Kierans (Miles Electronics, Ltd.). Nuclear Power, 6: No. 58, 77-80(Feb. 1961).

Equations for reactor kinetics, xenon poisoning, and heat transfer are given for use in general and special-purpose computers. They were coupled to form an analog of Merlin reactor under operating conditions and found to agree with calculated data. The merits of the general purpose and special computers are compared. (D.L.C.)

10417 CONTROL ROD ECONOMICS. W. K. Anderson (Knolls Atomic Power Lab., Schenectady, N. Y.), C. J. Beck, and J. S. Theilacker. Nuclear Sci. and Eng., 9: 1-15 (Jan. 1961).

The cost of control rods, which contributes a significant fraction to the total cost of a power reactor core, is discussed as a function of metallurgical composition and reactor endurance. Materials considered include hafnium, Cd5-In15-Ag80 alloy, several boron carrying systems, and dispersions of such rare-earth oxides as Eu_2O_3, Gd_2O_3, and Dy_2O_3. Costs based on a thorough analysis of processing variables and raw material prices are presented for a variety of rods for a specific reactor design considered typical of enriched power plants of the present generation. Concentrations were established by an approximate method described by Stevens. Although this method is relatively crude, the results are considered adequate. For long-lived cores the lowest cost rods of proved composition were a composite rod with hafnium tip and boron dispersion upper blade or hafnium rods if the hafnium can be bought at presently quoted zirconium co-product prices. Rare-earth

cermets of properly adjusted composition also fell into an interesting price range. Boron dispersions though lower in cost cannot be considered among the proved materials for long-lived high burn-up cores. For shut down rods or cores of shorter endurance, boron steels offer a low cost solution to the problem. For cores of intermediate endurance or shut down rods for longer endurance cores, Cd–In–Ag alloy rods may be of use and are certainly economically attractive. (auth)

10418 VALIDITY OF THE HOMOGENIZATION APPROXIMATION FOR END-LEAKAGE CALCULATIONS. Joe R. Beeler, Jr. (General Electric Co., Cincinnati). Nuclear Sci. and Eng., 9: 35-40(Jan. 1961).

The validity of using the homogenization approximation in a lattice end-leakage calculation was studied in a series of Monte Carlo scattering order analysis experiments. A method for using the homogenization approximation in Monte Carlo end-leakage calculations is described. The analysis indicated that, even with hydrogen moderation, a treatment of all collision sequences of fifth order or less in a faithful mock-up of the lattice was required to describe the end-leakage fraction accurately. In the case of non-hydrogenous moderators it was necessary to consider longer sequences. When all collision sequences of 10th order or less were treated in a faithful mock-up of the lattice, 80% of the total end-escape fraction was accounted for in a rigorous manner and a good estimate of the end-escape spectrum was obtained down to 25 kev. Escape fraction and spectrum estimates based on numerical integration over all scattering sequences of second order or less in a faithful lattice mock-up are shown to be misleading. The two essential factors that caused the lattice and homogeneous model results to differ were the smaller mean free path and larger absorption cross section of the homogeneous model and the directional character of the mean free path and absorption cross section in the lattice. As a result, longer collision sequences are required, on the average, to produce escape in the homogeneous model than in the lattice. (auth)

10419 SM-2 FLEXIBLE CRITICAL EXPERIMENTS. W. J. McCool, R. A. Robinson, E. W. Schrader, and S. H. Weiss (Alco Products, Inc., Schenectady, N. Y.). Nuclear Sci. and Eng., 9: 47-54(Jan. 1961).

The cold, clean, steel-reflected, final, SM-2 mock-up containing 36.4 kg U^{235} and 61 g B^{10} maintained criticality after a seven rod bank withdrawal of 6.974 in. and had an "excess K" (ΔK_E) of 1520 cents. An infinite steel-water laminated reflector is worth approximately +85 cents over the infinite water-reflected core. The measured reactivity coefficient, at 2000 psi, ranged from −1.15 cents/°F at 150°F to −5.20 cents/°F at 510°F. The integral reactivity effect of raising the SM-2 core water temperature from 103 to 510°F at 2000 psi and the water in the reflector coolant graph from 103 to 477°F at 2000 psi was −889.7 cents. The average measured material coefficients for U^{235} and B^{10} were 0.157 cents/g and 42.54 cents/g, respectively. Without the benefit of flux suppressors the maximum-to-average power ratio of 7.28 occurred at the top of the fuel section of control rod C (withdrawn to 7.14 in.), and a ratio of 5.28 occurred at the bottom of stationary element 43 and symmetric elements. (auth)

10420 LET THE REACTOR PREVENT XENON INSTABILITY. G. C. Fullmer (General Electric Co., Richland, Wash.). Nuclear Sci. and Eng., 9: 93-4(Jan. 1961).

The prediction of xenon spatial oscillations in large high-flux reactors is discussed. Two concepts in approaching this problem are described: local buckling, or what might be called a "pseudo k_∞"; and very long periods or "trends" indicative in cases of constant total reactor power of increasing or decreasing local bucklings. Use of these concepts is aimed at obviating oscillations rather than describing them mathematically. (M.C.G.)

10421 SL-1 EXPLOSION KILLS 3; CAUSE AND SIGNIFICANCE STILL UNCLEAR. Nucleonics, 19: No. 2, 17-23(Feb. 1961).

The SL-1 reactor accident of Jan. 3, 1961 is described; and the emergency organization, public reaction, significance, and cause are discussed. The condition of the reactor and the containment of the radiation are described. AEC established three advisory groups to determine the following: accident cause, decontamination and other site operations, and future disposition of the SL-1. Public and press reaction has been mild. The Army reactor program is unaffected. AEC initiated an immediate safety survey. (T.R.H.)

10422 CHEMONUCLEAR REACTORS, WHERE DO THEY STAND? Nucleonics, 19: No. 2, 47-52(Feb. 1961).

After a brief survey of chemonuclear reactor studies in progress, reactor design considerations are discussed. The fuel must be thin ribbons, plates, a porous material, or a dust for intimate contact with the reactants. Reactor stability is a problem with the process stream moving through the core. Decontamination of the process stream will be necessary. Optimum fuel particle size or plate thickness is 1 to 10 μ and reactor loadings of interest have 0.1 to 2 lb of fuel per pound of process fluid. Several fuel arrangements are outlined. The Hercules Powder Company scheme for producing ethylene glycol from methane is described in detail, including results of irradiation studies. (T.R.H.)

10423 PRESSURE TRANSIENTS FOLLOWING LOSS OF COOLANT. R. Casini and F. Dalla Volta (Societá Elettronucleare Italiana, Milan). Nucleonics, 19: No. 2, 84-8(Feb. 1961).

A method is given for calculating the transient pressure vs. time after an initial peak from a loss-of-coolant accident in a water-cooled and -moderated reactor. Certain assumptions are made to make hand calculation feasible. (T.R.H.)

10424 DETERMINATION OF IMPURITIES IN THE WWR-S REACTOR COOLING WATER USING γ-SPECTROSCOPY. Krystyna Józefowicz and Lesław Adamski (Inst. of Nuclear Research, Warsaw). Nukleonika, 5: 617-28(1960). (In English)

The decay and γ spectra of the active impurities in the EWA reactor cooling water were investigated by means of a scintillation spectrometer. Water samples were measured in a period of 8 sec to 6 months after the collection of a sample. Chemical separation was applied using isotopic carrier techniques. Fourteen isotopes originating from water, steel, aluminum, and fission products were found. The specific activities of three main isotopes were determined. The total activity changes during the 6-month operation period of the reactor are measured and discussed. (auth)

10425 INSTRUMENTATION FOR A SUBCRITICAL HOMOGENEOUS SUSPENSION REACTOR. I. REASONS BEHIND THE CHOICE OF A HOMOGENEOUS SUSPENSION REACTOR. J. J. Went. Philips Tech. Rev., 21: 109-21 (Mar. 12, 1960).

In the KEMA laboratories at Arnhem a one-zone homogeneous suspension-type reactor is in development. The

choice fell on a one-zone homogeneous reactor with circulating fuel in the form of a suspension of ThO_2-UO_2 particles in heavy water. The fissile material, U^{233}, is bred in the reactor itself from Th^{232}. The first step in the development program was to build an experimental subcritical reactor of this type, but operated on a suspension of UO_2 particles (natural uranium with 20% U^{235}) in ordinary water. Numerous measurements have been carried out on this reactor, among them the determination of the critical concentration of fissile material. (auth)

10426 INSTRUMENTATION FOR A SUBCRITICAL HOMOGENEOUS SUSPENSION REACTOR. II. MEASUREMENT AND CONTROL OF OPERATING PARAMETERS. B. L. A. van der Schee and M. van Tol. Philips Tech. Rev., 21: 121-33 (Mar. 12, 1960).

In experiments on the subcritical suspension reactor at Arnhem, the temperature can be kept constant within 0.1°C at any desired value between room temperature and 100°C. Since the circulation pump supplies about 5 kw to the fluid, the operating temperature is determined by the rate of cooling. Regulation is effected by slightly overcooling and correcting the excess with a heater whose output is variable between 0 and 5 kw and which is controlled by a resistance thermometer. This is contained in the pipeline from the heater to the reactor vessel. The mean concentration in the reactor vessel is found from the difference in hydrostatic pressure; in the case of a spherical-type vessel this is not done directly but by means of a "simulator." The flow rate is measured with a special venturi tube. The principal operating parameters are recorded. A simplified flow-sheet showing the general arrangement and operation of the reactor is given. (auth)

10427 INSTRUMENTATION FOR A SUBCRITICAL HOMOGENEOUS SUSPENSION REACTOR. IIIA. THE MONITORING OF LOW NEUTRON FLUX BY MEANS OF FAST PULSE-COUNTING CHANNELS. J. J. van Zolingen. Philips Tech. Rev., 21: 134-44 (Mar. 12, 1960).

A description of the pulse-counting channels used for monitoring the neutron flux in the KEMA subcritical suspension reactor is given. The components developed in the KEMA laboratory include a "millivolt discriminator" for pulses from as low as 12 mv at up to several million pulses per second and an improved fast-response flip-flop circuit capable of handling 15×10^6 pulses per second. The linear integrator is based on a "pump circuit," and the logarithmic integrator comprises eight such circuits in parallel. In the latter there exists a logarithmic relation between the meter deflection and the counting rate n, extending from $n = 1$ to $n = 3 \times 10^6$ pulses per sec ($6\frac{1}{2}$ decades). (auth)

10428 INSTRUMENTATION FOR A SUBCRITICAL HOMOGENEOUS SUSPENSION REACTOR. IIIB. THE MONITORING OF HIGH NEUTRON FLUX WITH THE AID OF AN ELECTROMETER. M. van Tol. Philips Tech. Rev., 21: 144-7 (Mar. 12, 1960).

A description of the monitoring system used in the KEMA subcritical suspension reactor for measuring the neutron flux in the range 2×10^3 to 2×10^6 neutrons/cm^2/sec is given. For this purpose, an ionization chamber and a vibrating-capacitor electrometer are used. The sensitivity of the electrometer is stabilized by strong negative feedback (loop gain 50); the meter has six measuring ranges and a linear scale. The minimum and maximum currents that produce full deflection are 5×10^{-10} and 1.6×10^{-7} amp, respectively. A calibrating device is incorporated for checking the operation of the instruments at any time. The monitoring system consists of two identical channels; each channel is powered from its own battery. (auth)

10429 INSTRUMENTATION FOR A SUBCRITICAL HOMOGENEOUS SUSPENSION REACTOR. IV. THE SAFETY CIRCUITS. F. J. Schijff. Philips Tech. Rev., 21: 148-52 (Mar. 12, 1960).

The KEMA subcritical suspension reactor contains three safety rods of boron carbide, which are suspended from electromagnets, the energizing current for which flows through a number of relay contacts in series. If one of the relays cuts out, the rods drop and the reactor is stopped. Each of the relays receives its energizing current via a thyratron, which can ignite only when its input voltage V_i is between -0.20 and -1.6 v, corresponding, respectively, to the lower and upper limits of the quantities to which the safety system is required to respond (neutron flux, reactor period, temperature, suspension flow rate, etc.). The voltage V_i is taken from the channels used for monitoring these quantities. Measures are taken to make the system "fail safe." (auth)

10430 THE SPATIAL VARIATION OF THE NEUTRON SPECTRUM IN A HETEROGENEOUS REACTOR MODERATED AND COOLED BY LIGHT WATER. I. Purica, A. Ştefănescu, and M. Sabău. Rev. phys., Acad. rép. populaire Roumaine, 5: 189-98(1960). (In French)

In the calculation of enriched uranium reactors cooled and moderated with natural water, the neutron spectrum is divided into three groups: thermal (characterized by the temperature of the neutron spectrum T_n), epithermal (characterized by the constant B), and fast (fission spectrum distribution). The variation of T_n, B, and the fission spectrum in the lattice of the reactor at the Institüt de Physique Atomique in Bucharet is studied. The spatial variation of the neutron spectrum can be characterized by the variation of the ratios ϕ_{ep}/ϕ_{th}, ϕ_f/ϕ_{th}, and T_n/T_o. The variation of the temperature does not go beyond the limits of the errors. The value of the temperature, determined by the method of the danger coefficient at the center of the lattice, does not differ, within the limits of these errors, from the temperature determined in the reflector by the use of a mechanical selector. (J.S.R.)

10431 PRIMARY PIPING SYSTEM OF THE YANKEE ATOMIC ELECTRIC PLANT. R. R. Rothermel and R. A. Loose (National Valve and Mfg. Co., Pittsburgh). Welding J. (N.Y.), 40: 119-24(Feb. 1961).

The size, wall thickness, and use of stainless-steel material for the primary piping system of the Yankee Atomic Electric Plant dictated unique fabrication techniques. Although the fabrication techniques for nuclear piping systems will soon be considered conventional, quality control standards must be maintained at a high level. The material, fabrication techniques, and control requirements for the primary piping system of the Yankee pressurized-water nuclear power plant located at Rowe, Mass., are described. (auth)

10432 NONPROPULSIVE POWER SYSTEMS FOR LONG-TIME APPLICATIONS. Bernard Lubarsky and Robert E. English (Lewis Research Center, Cleveland). Presented at the CAI-IAS Joint Meeting, Montreal, Canada, October 17-18, 1960. IAS Paper No. 60-97. New York, Institute of the Aeronautical Sciences, 1960. 27p. $1.00.

At present solar photocells are the prominent source of power for long-time nonpropulsive applications in space, and they will maintain this prominence for powers below a kilowatt or so. Thermoelectric power supplies are being developed for use with solar, radioisotopic, and reactor energy sources; these systems will be useful in applications involving impact or long periods of darkness. Turbogenerator systems employing solar and reactor energy

sources are being developed for powers of several kilowatts and up; their use for nonpropulsive applications is several years away. Thermionic emitters are the basis for promising future systems, but their real potential cannot yet be evaluated. (auth)

10433 RESONANCE ABSORPTION IN NUCLEAR REACTORS. Lawrence Dresner. International Series of Monographs on Nuclear Energy. Division X. Reactor Design Physics. Volume 4. New York, Pergamon Press. 1960. 138p. $6.00.

A treatment of resonance absorption in reactors is presented which explains the theory in detail and then compares theory with experiment. Absorption in homogeneous media is fully treated, and absorption in tight lattices, by complex fuel elements and by single lumps is considered. (D.L.C.)

10434 IMPROVEMENTS IN OR RELATING TO PROTECTIVE CANS FOR NUCLEAR REACTOR FUEL ELEMENTS. (to General Electric Co., Ltd.). British Patent 855,661. Dec. 7, 1960.

A finned tube design for reactor fuel elements is described in which the fins are slotted and longitudinal, and baffles are interposed between adjacent fins. Each baffle is arranged so that its distance from the tube body varies from a maximum at one end (fin tips) to a minimum at the other end (fin roots). The advantages of this design are that the heat transfer performance of the tube is improved, radial coolant temperature gradients are reduced by the baffles, and the longitudinal fins strengthen the tube better than transverse fins. (D.L.C.)

10435 IMPROVEMENTS RELATING TO NUCLEAR FUEL ELEMENTS. (to General Electric Co.). British Patent 858,991. Jan. 18, 1961.

A reactor fuel element containing Th^{232} as the fertile material was designed with a shielding material that absorbs neutrons of energy 0.05 to 10.0 ev. This neutron absorption prevents formation of U^{235} from Th^{232}, which is not as desirable as U^{233}. The shielding material should be either one of the plutonium isotopes or a mixture thereof, or U^{238} which forms plutonium upon neutron capture and decay. Among the possible configurations of this fuel-element type are rods, tubes, and plates. (D.L.C.)

10436 IMPROVEMENTS IN VESSELS OR RECEPTACLES FOR USE WITH NUCLEAR REACTORS. Jacoby Boye Jacobsen. British Patent 859,072. Jan. 18, 1961.

A pressure vessel designed for use with reactors is described. The vessel consists of two or more receptacles, one within the other, with a ductile material, e.g., lead, in the space between the receptacles to equalize pressures. A manhole may be provided in the vessel. (D.L.C.)

10437 IMPROVEMENTS IN NUCLEAR REACTORS AND IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Ronald Haynes (to Babcock and Wilcox Ltd.). British Patent 859,202. Jan. 18, 1961.

A fuel-element assembly was designed for gas-cooled graphite-moderated reactors. The assembly consists of a finned fuel element seated in a sleeve with a space in between for coolant flow. The advantages of this element-sleeve design are avoidance of element damage during handling, avoidance of major contamination of the reactor moderator in case of element rupture, simplified element support problems, and flexibility of element design. The internal diameter of the sleeves is tapered from bottom to top so that coolant flow increases going upward, resulting in operation of the fuel elements in one channel at the same temperature. The taper is also varied with the channel position in the core so that greater cooling occurs in the core center. (D.L.C.)

10438 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Donald Mason Sutherland and Philip Rawson Tipper (to AEI-John Thompson Nuclear Energy Co., Ltd.). British Patent 859,351. Jan. 18, 1961.

Equipment was designed for loading and unloading fuel elements into and out of the fuel channels of a solid-moderated reactor. Vertical charging passages are provided in the charging floor above the core at the centers of areas of cruciform outline, each area having a control rod at each internal and external corner but no control rods within the area. This arrangement prevents fouling of the control rods. The charging chute was designed so that a fuel element does not have to pass around a corner. (D.L.C.)

10439 HIGH TEMPERATURE, HIGH POWER HETEROGENEOUS NUCLEAR REACTOR. (to United States Atomic Energy Commission). British Patent 859,356. Jan. 18, 1961.

A gas-cooled graphite-moderated power reactor was designed in which fuel elements can be replaced during reactor operation. In this reactor, fuel elements are supported in horizontal radial channels in the core which is arranged as a rotor or turret within a stationary reflector. Fuel elements are loaded at the periphery of the core and are stepwise moved toward the center as burn-up proceeds. A central plenum within the core provides an inlet coolant passage and a spent fuel dump. Nitrogen at ~500 psi pressure is used as coolant. (D.L.C.)

10440 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Gordon McConochie Insch (to English Electric Co., Ltd.). British Patent 859,369. Jan. 18, 1961.

A graphite-moderated gas-cooled reactor core was designed for use in a spherical pressure vessel. The core or moderator structure is divided into concentric zones, each zone being of greater depth than the immediately succeeding outer zone. This design allows a greater mass each of moderator and fuel to be accommodated in a pressure vessel of given size. (D.L.C.)

10441 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. Derek Moore and Herbert Henry Heath (to English Electric Co., Ltd.). British Patent 859,811. Jan. 25, 1961.

A mechanism for varying the position of a control element in a reactor core is designed consisting of a drum, a cable for suspending the control element from the drum, and a driving motor. The drum is designed to wind the cable in layers so that the radius of the torque exerted by the drum on the cable decreases as the cable is unwound. The motor is of the a-c synchronous type and has a free-wheel device so that winding and unwinding of the cable is accomplished by the motor and the weight of the cable, respectively, with the motor acting as a brake in the latter case. The speed and torque of the motor are changed by varying the frequency of its supply source. One of the three guide sheaves is so arranged that, near the end of the unwinding of the cable, it absorbs the kinetic energy of the cable. Thus, when the control element needs to be inserted rapidly into the core, as in shutdown, its descent is controlled by the inertia of the winding mechanism, the braking torque of the motor, the decreasing radius of the torque of the cable on the drum, and the absorption of kinetic energy by the guide sheave near the end of the descent. (D.L.C.)

10442 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. William George Edgar Wood (AEI-John

Thompson Nuclear Energy Co., Ltd.). British Patent 859,930. Jan. 25, 1961.

A gas-cooled reactor core consisting of vertical stacks of graphite blocks with interposing slabs is designed so that allowance is made for Wigner growth without coolant leakage from the fuel channels. The allowance for Wigner growth is effected by graphite blocks with vertical grain, slabs with mutually perpendicular grain, and gaps between the graphite pieces; coolant leakage through the gaps is minimized or prevented by graphite sealing rings fitted into the end faces of the blocks and/or slabs. (D.L.C.)

10443 IMPROVEMENT IN HEAT TRANSFER. (to Commissariat à l'Énergie Atomique). French Patent 1,200,408. June 29, 1959.

Three methods are disclosed for improving the heat transfer of fuel elements, equalizing their surface temperature, decreasing neutron absorption by the canning material, and decreasing pressure losses in the coolant channels. These methods consist in varying some parameter along the length of the channel. This parameter can be the height of the fins of longitudinally finned fuel rods, the number of fuel plates that are axially and parallelly mounted in the channel, or the indentation of undulated fuel rods or tubes. In all cases the fuel is uniformly distributed along the channel. (NPO)

10444 STRUCTURE OF FUEL ELEMENTS FOR ATOMIC REACTORS. (to Commissariat à l'Énergie Atomique). French Patent 1,201,636. July 15, 1959.

The fuel elements described in this invention consist of a string of alternately placed small fuel strings of different diameter, on which a protective sheath has been applied by means of plastic deformation. As a consequence the sheath displays local longitudinal folds. (NPO)

10445 PROTECTING COATING FOR FUEL ELEMENTS. (to Deutsche Gold- und Silber-Scheideanstalt, vormals Roessler). French Patent 1,201,819. July 15, 1959.

A zirconium slug can is described which has a wall thickness of 0.7 to 10 mm and on which an exterior steel coating of 30 to 300 μ, preferably 50 to 200 μ, thickness has been applied. This coated can has at the same time a low neutron absorption, a high mechanical strength, and a high corrosion resistance above 300°C. A similar coating may also be applied on the interior surface of the can. (NPO)

10446 COMPOSITION OF HOMOGENEOUS REACTOR FUEL. (to North American Aviation, Inc.). French Patent 1,202,280. July 20, 1959.

In order to prevent the precipitation of uranyl peroxide and to increase the energy production of homogeneous reactors, an aqueous fuel solution of the following composition is used: 75 to 750 (preferable 200 to 350) g/liter UO_2SO_4, 17 to 600 (60 to 280) ppm of a metal ion that is capable of existing in more than one valency state (e.g., 16 to 560 ppm iron as $Fe_2(SO_4)_3$ and 1 to 4 ppm copper as $CuSO_4$), 13 to 150 (26 to 84) g/liter H_2SO_4, and the balance water. The proportions should be 0.17 to 2 (0.3 to 0.8) mg metal ion and 0.13 to 0.5 (0.13 to 0.24) g H_2SO_4 per gram uranium. (NPO)

10447 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Hawker Siddeley Nuclear Power Co., Ltd.). French Patent 1,203,228. July 27, 1959.

A canned fuel rod is described which is provided with an axial cavity over its entire length, this cavity being closed at its extremities by the can. The cavity may be filled with a dispersion of a fissile or fertile oxide or carbide in graphite, beryllium, or BeO. (NPO)

10448 METHOD OF MANUFACTURING FUEL ELEMENTS. (to Siemens-Schuckertwerke A. G.). French Patent 1,204,115. Aug. 3, 1959.

Fuel elements with a good mechanical contact between the fuel core and the can are manufactured by filling the can with successive layers of powdery fuel and cold or hot compacting or pressure sintering the contents after each filling. Alternatively a solid fuel core may be brought into the can and the interstices between this core and the can may be filled with powdered fuel in the manner described. (NPO)

10449 FUEL ELEMENTS FOR ATOMIC PILES. (to United Kingdom Atomic Energy Authority). French Patent 1,204,148. Aug. 3, 1959.

A fuel element assembly is described, which consists of a number of parallel fuel plates, the surfaces of which are ribbed or finned in a herringbone pattern. Adjacent surfaces facing each other have mutually inverted patterns. This arrangement brings about a helical circulation of the coolant. (NPO)

10450 REACTIVITY CONTROL DEVICE FOR NUCLEAR REACTORS. (to British Thomson-Houston Co. Ltd.). French Patent 1,204,462. Jan. 26, 1960.

In order to get a substantially linear relationship between the reactivity and the position of the control rods, these rods (movable in a vertical direction) are grouped in such a manner that the channels of the respective groups lie at the corners of concentric polygons. Equipment is provided to move the rods of the same group simultaneously and independently of the rods of the other groups. The movement of the groups is performed successively, e.g., in such a manner that first the rods of the outermost groups are raised and then those of the succeeding groups; the rods are lowered in exactly the reverse order, viz., first those of the innermost groups and then successively those on the outside. The movement of a succeeding group begins before the movement of the preceding group is ended. (NPO)

10451 MODE OF TRANSFORMATION OF THE NOCTURNAL POWER EXCESS OF NUCLEAR POWER PLANTS. (to M. F. Marguerre). French Patent 1,205,566. Feb. 3, 1960.

The nocturnal power excess in nuclear power plants is transferred by cooling devices to coolant water, which is thus heated to above 50°C. This hot water is collected in a known manner in accumulators, from where steam is exhausted either directly or through pressure-reducing valves, whereby the residual content of the accumulator is cooled. The exhausted steam is fed by compressors to other accumulators at a higher pressure. From these accumulators the steam is led if necessary, into a turbogenerator where it is expanded totally. This turbogenerator drives the compressor, while the generator works as a motor during the starting. (NPO)

10452 FLUID CIRCUITS. (to United Kingdom Atomic Energy Authority). French Patent 1,206,226. Feb. 8, 1960.

In order to intercalate an element (comprising, for instance, a pumping system) into a fluid circuit enclosed inside a containing shell (suitably for a nuclear reactor), the shell is made with a re-entrant section forming a cavity and extending into the inside of the shell, in which cavity the intercalated element is mounted. This cavity has openings that are connected to the conduit parts inside the containing shell and are in front of openings in the intercalated element, mounted in the cavity. One of the openings is arranged at the bottom of the cavity, sealed tightly to the corresponding opening in the element; the opening in the containing shell is sealed to a shoulder of the intercalated element. (NPO)

10453 A NUCLEAR REACTOR WITH PROVISION FOR THE CHANGING OF FUEL ELEMENTS DURING OPERA-

TION. (to Brown, Boveri & Cie. A. G.). French Patent 1,206,557. Feb. 10, 1960.

A nuclear reactor with provision for the changing of fuel elements during operation has a container which includes the reactor, the cooling circuit, and the heat exchanger. The container has a double wall of metal and a concrete wall interposed between these metal walls and constituting a screen against radiations. Interjacent gas spaces, 2 to 3 cm in width, are provided between the metal walls and the concrete wall. The gas in these spaces is purified by special means. (NPO)

10454 IMPROVEMENTS IN OR RELATING TO THE UTILISATION OF THE HEAT FROM NUCLEAR REACTORS. (to M. A. Rutenberg). French Patent 1,206,820. Feb. 11, 1960.

In order to achieve high efficiency of the electrical power production in a nuclear power plant the temperatures of the thermodynamic cycle must be chosen suitably. The entrance temperature of the reactor coolant is limited for reasons of safety. The latter temperature may often be lower than the optimum temperature derived by thermodynamic considerations. In order to meet the two conditions, in a nuclear reactor having a closed coolant circuit, two heat exchangers are connected in series so that the exchanger working at the higher temperature is used for transferring the heat to a working fluid. The heat is finally used for producing electric power. The heat transferred to the second exchanger is used as chemical process heat. (NPO)

10455 CERAMIC NUCLEAR FUEL ELEMENTS. (to Compagnie des Meules Norton). French Patent 1,206,858. Aug. 31, 1959.

Methods are given for manufacturing cylindrical, spherical, annular or disk-shaped fuel elements, which consist of an envelope of a refractory metal oxide (Al_2O_3, MgO, ZrO_2, CaO, CeO_2, BeO, ThO_2 or their mixtures) enclosing a core of a fissile and/or fertile metal oxide, to which one or more such oxides may be added. These fuel elements are characterized by a high temperature corrosion and radiation resistance and are highly retentive of fission products. (NPO)

10456 IMPROVEMENTS IN NUCLEAR REACTOR FUEL ELEMENTS. (to C. A. Parsons & Co., Ltd.). French Patent 1,206,933. Aug. 31, 1959.

A ladder type fuel element is described. It consists of two parallel columns or a (graphite) tube and an assembly of obliquely fixed parallel fuel plates that are supported by these columns or tube. (NPO)

10457 IMPROVEMENTS IN PRESSURIZED WATER REACTORS. (to Société Rateau S. A.). French Patent 1,207,488. Feb. 17, 1960.

In a pressurized-water reactor a part of the water heated in the reactor and then withdrawn is expanded in order to evaporate it. The pressure drop of this expanding fluid is used to drive a fluid motor. This fluid motor may serve to circulate the pressurized water in a second closed circuit through the reactor core. An auxiliary motor may be used, coupled to the fluid motor or working in parallel with it, for completing the load demand of the circulation pump. This auxiliary motor may be electric or a Pelton turbine. (NPO)

10458 CONTROL ROD DRIVE FOR NUCLEAR REACTORS. (to Société Alsacienne de Constructions Mécaniques). French Patent 1,209,297. Mar. 1, 1960.

A control rod drive is offered which comprises a horizontal shaft winch, to hoist or let down the cable from which the rod is suspended, in combination with an eddy-current brake mounted on the same axis, the winch being controlled by an electric motor. The groove provided for the cable on the winch drum approaches the axis toward the end of the run of the cable, in order to get a progressive action by reduction of torque produced by the control rod. This action is coupled with an increase of the brake action. (NPO)

10459 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Babcock & Wilcox Ltd.). French Patent 1,209,889. Mar. 4, 1960.

A nuclear reactor is offered comprising coolant channels in which the nuclear fuel elements are placed. The reactor is divided into a plurality of distinct zones, within which the channels are grouped, so that the heat produced in the channels of the same zone does not undergo an essential variation. The channels of the same zone are incorporated in a distinct cooling circuit. The circuits of the different zones work in parallel. Preferably, in a cylindrical reactor core, these zones are concentric. The circulations in the different circuits are independently regulated, preferably at the points where the coolant enters the reactor. The fluid coming from the outermost zone may be transmitted to heat exchangers at a lower temperature than the fluid coming from the more central zones. (NPO)

10460 FUEL ELEMENT FOR HIGH TEMPERATURE NUCLEAR REACTOR. (to Electricité de France). French Patent 1,210,254. Sept. 28, 1959.

The fuel element consists of a metallic core and a ceramic or refractory can which is permeable to fission gases but impermeable to liquid uranium and has a low neutron absorption. Preferred canning materials are graphite, BeO, MgO, and Al_2O_3. In an embodiment of the invention the can consists of a cylindrical container and a top cover. The cylinder can be provided with lateral centering fins. (NPO)

10461 CHARGING DEVICE FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,210,803. Mar. 10, 1960.

For the charging or discharging of fuel elements in a nuclear reactor, there is provided, for a group of fuel-element channels, a mechanism comprising a vertically mounted rod, able to turn on its own axis and provided with a channel that is axial at the top of the rod and curves outward toward the bottom of the rod so that its lower opening is in the side of the rod. Via this channel a central tube, attached at the upper end of the rod, can be brought into connection, by rotation of the rod, with any one of a group of tubes extending upward from the fuel-element channels and arranged with their upper openings on a level with the lower opening in the rod and on the periphery of a circle about the center of which the rod rotates. Preferably this charging system is combined with a system for compressing the moderator structure by the group of tubes, the rod and the underlying group of tubes being forced by spring action against the moderator structure. (NPO)

10462 DEVICES GENERATING ELECTRICITY. (to Westinghouse Electric Corp.). French Patent 1,211,016. Oct. 5, 1959.

The heat developed by nuclear fission is converted partly into electricity in a direct way by means of cylindrical thermoelectric elements. A series of these elements is enclosed between coaxial cylindrical metal envelopes overlapping each other and having a length about twice that of each thermoelectric element and serving also to connect the elements electrically. The assembly forms a tube into

which a nuclear fuel can be introduced, so as to give a nuclear fuel element, which can be cooled by a liquid flowing on the outside. Alternatively a liquid fuel can be situated outside and a cooling liquid inside the tube. (NPO)

10463 METHOD AND APPARATUS FOR DECONTAMINATING NUCLEAR REACTORS. (to A. G. "Weser"). French Patent 1,211,274. Oct. 5, 1959.

A scheme for a nuclear reactor is given in which the solid moderator is provided with separate vertical cooling and fuel channels, the latter being connected with a decontamination plant. A side stream, branched off from the coolant outlet, is applied to sweep the fuel elements; contamination of the primary cycle with fission products is thus prevented. A further improvement consists in sheathing the fuel elements in such a way that the sheath contacts the channel wall and the sweep fluid is forced to flow between the fuel element and the sheath. The sheathed elements are supported at the bottom of each channel by a piston. Prior to charging and discharging operations the coolant is made to exert back pressure on the pistons, which causes the latter to bar the channel outlet. (NPO)

10464 HEAT ABSORPTION DEVICE FOR A NUCLEAR REACTOR FOR USE AFTER SHUTDOWN OR A COOLING LOSS INCIDENT. (to Commissariat à l'Énergie Atomique). French Patent 1,211,537. Mar. 16, 1960.

In a boiling-water reactor, comprising an annular tank filled with water and surrounding the principal reactor tank, a bundle of cooling tubes is arranged in the water of this annular tank and these tubes are in connection with the principal reactor tank so that after shut-down in the case of a cooling loss incident the heat produced in the reactor is transferred by this tube bundle to the water in the annular tank, the connection being a short-circuit to the normal exterior working circuit of the evaporating fluid. A second tube bundle arranged inside the said annular tank constitutes a part of an auxiliary cooling circuit withdrawing the heat from this tank. (NPO)

10465 NEW MODE OF PILING THE SOLID MODERATOR BLOCKS IN A NUCLEAR REACTOR. (to Commissariat à l'Énergie Atomique). French Patent 1,211,573. Mar. 17, 1960.

In order to guarantee the alignment of the channels crossing the core of a nuclear reactor constituted by a pile of graphite blocks (this pile is built up in such a way as to allow the anisotropic expansion of the blocks), the blocks are arranged in a regular square lattice and are stacked one above the other in such a way that their central holes form the channels. They are connected by independent keys, having an oval parallelly faced lozenge shape, each key fitting in the corresponding slots of two succeeding blocks of the same column and in the slots of the corresponding blocks of an adjacent column. Succeeding keys having the same orientation and forming a row in a direction perpendicular to their faces are held at a distance by prismatic spacers lying in grooves provided at the horizontal edges of the blocks. (NPO)

10466 DEFECT DETECTION DEVICE FOR A NUCLEAR REACTOR. (to General Electric Co. Ltd.). French Patent 1,211,949. Mar. 18, 1960.

In order to localize burst fuel elements in a reactor, the coolant which was in connection with the fuel elements is examined for its content of fission products. To this end the coolant is led through a chamber to collect the positive ions formed by the decay of the fission products (particularly xenon and krypton). The ions are attracted by electrostatic means to a movable band that brings the ions in front of a counter, which thus indicates the quantity of fission products in the gas. (NPO)

10467 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Babcock & Wilcox Co.). French Patent 1,212,073. Mar. 22, 1960.

In order to compensate the depletion of the nuclear fuel elements during the run of the reactor by increase of the moderator action, light water is progressively added to dilute the moderator (which is preferably composed of heavy water). This compensation method may also be used to control the chain reaction in the reactor by changing the ratio heavy water/light water, and may preferably be applied to reactors comprising fissile and fertile materials in separate elements. (NPO)

10468 IMPROVEMENTS IN NUCLEAR FUELS. (to General Electric Co.). French Patent 1,212,233. Oct. 19, 1959.

UO_2 fuels with improved thermal conductivity are prepared by mixing 60 to 75 vol.% UO_2 (grain size 25 to 100 μ) and 25 to 40 vol.% BeO or SiC (grain size 1 to 5 μ), compacting, and then sintering. (NPO)

10469 PRESTRESSED CONCRETE SHELL FOR NUCLEAR REACTORS. French Patent 1,213,663. Apr. 4, 1960.

A prestressed concrete shell able to resist the pressure inside a nuclear reactor and serve at the same time as a radiation shield has approximately the form of a cylinder terminated at its ends by hemispheres with their hollow sides outward. The prestressing is effected by straight cables embedded in the concrete; some are parallel to the principal axis of the cylinder and others are perpendicular to it. The latter are therefore parallel to the tangential lines of the cylinder. It is preferred, for any given place and direction, to use not one cable, but two, arranged parallel and a short distance apart. (NPO)

10470 NEW MODE OF CONNECTION OF THE SOLID MODERATOR OF A NUCLEAR REACTOR WITH VERTICAL CHANNELS ARRANGED IN A HEXAGONAL LATTICE. (to Commissariat à l'Énergie Atomique). French Patent 1,214,246. Apr. 7, 1960.

In order to guarantee the alignment of the channels crossing the core of a nuclear reactor constituted by a pile of hexagonal prismatic graphite blocks (these blocks being arranged in a regular hexagonal lattice), the blocks are stacked one above the other in such a way that their central holes form the said channels. Keys with parallel side faces fitted in radial slots grooved in the side faces of the blocks connect succeeding blocks of the same column to the corresponding blocks of an adjacent column. Because of the anisotropic expansion of the blocks, the columns must be separated by free spaces; the keys must have a sufficient clearance to be able to slide freely in the slots. (NPO)

10471 HEAVY WATER COOLED OR MODERATED NUCLEAR REACTOR. (to M. H. Römer). French Patent 1,214,670. Apr. 11, 1960.

In order to avoid heavy-water escape in a nuclear reactor, all important parts of the heavy-water circuit are enclosed in a tight container, through which gas is circulating. The gas exhaust is connected with a dehydration device that recovers any heavy-water vapor that is present in the gas stream. (NPO)

10472 METHOD FOR PREPARING DISPERSION FUEL AND BREEDING ELEMENTS FOR NUCLEAR REACTORS. (to Deutsche Gold- und Silber-Scheideanstalt vormals Roessler). French Patent 1,214,754. Nov. 9, 1959.

Dispersion fuel and breeding elements are manufactured by impregnating porous graphite or graphite in which cavities (e.g., channels) have been made, with uranium, plutonium, thorium, or their alloys. The metals can be transformed into carbides by a final thermal treatment of the impregnated graphite. (NPO)

10473 NUCLEAR REACTOR USING URANIUM HEXAFLUORIDE. (to Metallgesellschaft A. G.). French Patent 1,215,187. Apr. 14, 1960.

A nuclear reactor comprises gaseous uranium hexafluoride as nuclear fuel and a turbine driven by the expanding gaseous fuel. The turbine forms a part of the reactor core, and the rotor, the blades, and the casing of the turbine are made from a metal of the group beryllium, copper, and nickel. They are protected from the action of the uranium hexafluoride by a layer of metal oxides of the group aluminum, magnesium, and beryllium. The outlet of the turbine may be connected with the inlet of a turbocompresser driven by the turbine rotor, this turbocompresser feeding the turbine. (NPO)

10474 PRODUCTS AND METHODS FOR COOLING NUCLEAR REACTORS. (to U. S. Atomic Energy Commission). French Patent 1,215,539. Nov. 23, 1959.

The reactor coolant consists of a low-melting mixture of polyphenyls which are composed of not more than four nuclei and are free of halogen atoms and nonaromatic substituents. Numerous examples are given (e.g., biphenyl + m-terphenyl or phenanthrene + o-terphenyl) and irradiation stabilities compared. Small quantities of antioxidants or substances that inhibit the formation or reactions of free radicals may be added. (NPO)

10475 IMPROVEMENT IN THE SUPPORTING OF FUEL ELEMENTS IN NUCLEAR REACTORS WITH VERTICAL CHANNELS. (to Commissariat à l'Energie Atomique). French Patent 1,215,911. Nov. 23, 1959.

A composite fuel element is offered which consists of a longitudinally finned fuel rod that is centered in an enveloping vertical graphite sleeve by means of the fins and supported at the bottom of the sleeve on a central graphite support, which is fixed to the sleeve with stainless-steel wires. The top of the sleeve is provided with an interior groove to permit charging and discharging operations. (NPO)

10476 NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,216,022. Apr. 21, 1960.

A working procedure is given for arranging the fuel elements of a nuclear reactor in channels that are grouped into several zones having different average flux density and for moving the fuel elements successively from one zone into the other (preferably in a radial direction inside the reactor) in order to ensure a sufficient irradiation rate and, in consequence of this, a sufficient depletion rate for all the fuel elements before they are discharged. (NPO)

10477 PROTECTING SHEATHS FOR NUCLEAR REACTOR SLUGS. (to General Electric Co., Ltd.). French Patent 1,216,181. Nov. 23, 1959.

A can is described for fuel elements, provided with a relatively large number of short helical fins and a restricted number of broad helical fins. The method of manufacture, partly by extrusion, and typical dimensions are given. (NPO)

10478 IMPROVEMENTS IN DEVICES FOR DETECTING BURST FUEL ELEMENTS IN NUCLEAR REACTORS COOLED BY A LIQUID COOLANT. (to Société Grenobloise d'Etudes & d'Applications Hydrauliques). French Patent 1,216,278. Apr. 25, 1960.

A gas is injected into the coolant of a nuclear reactor in order to take off the gaseous fission products by scrubbing. The injection takes place at the lower end of the fuel-element cells and is separated in degassing equipment associated with these fuel-element cells. The gaseous fission products entrained by the scrubbing gas are brought in front of a counter in order to measure their activity; the failure of a fuel element is thus indicated by the activity of the fission products which escape from the burst element. (NPO)

10479 CONTROL SYSTEM FOR NUCLEAR REACTORS. (to General Electric Co. Ltd.). French Patent 1,216,577. Apr. 26, 1960.

In order to regulate a nuclear power reactor the coolant flow and the reactivity are controlled at the same time. The power demand signal is compared with the coolant flow indication, the differential signal controlling the coolant circulator. The power demand signal has a maximum permissible rate of change. The same power demand control influences a function generator, preferably with a linear function, which converts the coolant flow indication into a transformed signal and which is compared with the neutron flux indication, the differential signal controlling the regulation of the reactivity by the control rods. (NPO)

10480 STABILIZATION DEVICE FOR A BOILING WATER REACTOR. (to Indatom). French Patent 1,217,195. May 2, 1960.

A stabilization device (preferably for a boiling-water reactor) comprises a neutron flux detector which gives an electric signal proportional to the neutronic power of the reactor. This signal is fed into a phase lead compensating network, the output of which controls a servomechanism that is in connection with a neutron absorbing device and enables the provision of a neutron absorber that is periodically variable in the same frequency as the neutron flux oscillations measured by the neutron detector and in a suitable phase shift to stabilize these oscillations. (NPO)

10481 PRESSURIZED WATER REACTOR WITH SUPER-HEATING. (to Siemens-Schuckertwerke A. G.). French Patent 1,218,251. Oct. 10, 1960.

A pressurized-water reactor comprises two separate cooling circuits transferring heat from these circuits by heat exchange to a working fluid circulating successively in the two heat exchangers. In one of the circuits pressurized water circulates; in the other steam is superheated. Each circuit incorporates tubes including nuclear fuel elements. Preferably, the tubes of a circuit may be arranged parallel and connected together at their ends by headers. The superheating circuit suitably comprises tubes closed at their lower ends, each enclosing another concentric tube in which the fuel elements are placed. The steam passes down the annular spaces between these tubes and then rises inside the inner tubes. (NPO)

10482 SHEATH FOR FUEL ELEMENTS OF HEAVY WATER MODERATED REACTORS. A. Huet. French Patent 1,218,526. Dec. 21, 1959.

A heavy-water-moderated reactor is provided with double-walled fuel-element channels, the annular space between both walls being closed at the top and a limited number of passages connecting this space with the interior of the channel. A gaseous coolant is circulated through the channel as well as through the annular space. To equalize heat transfer the channels can locally have a conical or undulating shape. (NPO)

10483 METHOD FOR PREPARING NUCLEAR REACTOR FUEL. (to U. S. Atomic Energy Commission). French Patent 1,219,081. Dec. 21, 1959.

A relatively stable suspension of UO_2 in liquid bismuth is prepared by heating and agitating above 850°C a mixture of Bi_2O_3, uranium and bismuth in which the ratio O/U = 1.67. (NPO)

10484 METHOD FOR BRINGING FUEL ELEMENTS INTO AND OUT OF A COOLING CHANNEL OF A NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,219,173. Dec. 21, 1959.

Fuel elements are made to rise or fall in the channels of gas-cooled reactors by increasing or decreasing the coolant pressure at one of their extremities. (NPO)

10485 NUCLEAR REACTOR. (to General Electric Co. Ltd.). French Patent 1,219,534. Mar. 18, 1960.

In order to compensate the changes in the distribution of the neutron flux in a nuclear reactor (the changes may be caused by the build-up of poison during the running time of the reactor), two neutron-absorbing elements are provided and coupled together in such a manner that the movement of one of these elements into the reactor (resulting in a local depression of the neutron flux) is coupled with a movement of the other element out of the reactor (resulting in a local rise of the flux) and vice versa, so that the total neutron flux of the reactor does not change. Suitably these elements are constituted by neutron-absorbing bars connected by a nonabsorbing central section; the bars may be moved in different channels by the same motor. (NPO)

10486 IMPROVEMENTS IN NUCLEAR REACTORS. (to AEI-John Thomson Nuclear Energy Co. Ltd.). French Patent 1,219,628. May 18, 1960.

A graphite moderator structure is described comprising columns of vertically stacked graphite bars. The grains thereof are orientated in the longitudinal direction of the bars; between two successive bars two thin graphite blocks are intercalated, one above the other, with their grain directions perpendicular to that of the stacked bars. These parts are maintained in position laterally by keys and keyways in the cooperating bars and blocks. In order to ensure the tightness of the channel provided in the center of the column, annular rings are fitted to the bars reaching from one end of each bar to the end of the succeeding bar and thus forming a part of the channel wall. (NPO)

10487 METHOD FOR MANUFACTURING ALLOY-BASED FUEL ELEMENTS. (to U. S. Atomic Energy Commission). French Patent 1,221,160. Jan. 11, 1960.

Shape-retaining fuel elements having a γ-phase uranium-alloy core and a zirconium-alloy can are manufactured by hot working at above 650°C a uranium-alloy ingot, that is prepared by fusion in an inert atmosphere or a vacuum, applying the zirconium-alloy can (wall thickness 0.38 to 0.76 mm), again hot working above 650°C in order to bond the can to the core, and rapidly cooling to ambient temperature. The composition of the uranium alloy is preferably 4 to 17% uranium, 7 to 16% zirconium, less than 0.15% impurities, and the balance uranium. The composition of the zirconium alloy is preferably 0.5 to 2.5% Sn, 0.05 to 1% Cr, 0.05 to 0.5% Ni, 0.05 to 0.5% Fe, less than 0.05% C, less than 0.5% impurities, and the balance zirconium. (NPO)

10488 TEMPERATURE CONTROLLED NUCLEAR REACTOR. (to Vitro Corp. of America). French Patent 1,221,255. June 1, 1960.

In a nuclear reactor having a strong negative temperature coefficient of reactivity, the liquid moderator is kept at a temperature below a maximum where the reactor becomes subcritical. This temperature control is achieved by regulating the temperature of the liquid moderator flowing in natural circulation from the bottom to the top and afterward sinking down in an annular space between the core and the containing shell; after being cooled at the containing wall, the temperature is controlled by a cooling skirt arranged outside the said shell. The reactivity may be adjusted by arranging supplementary fuel elements in the center of the reactor core. (NPO)

10489 FUEL ELEMENTS FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority and General Electric Co., Ltd.). French Patent 1,221,945. Jan. 18, 1960.

A metallic fuel slug is thermally treated to improve its radiating properties, stripped of its superficial oxide layer, and introduced into its protecting sheath. The latter is hermetically sealed and put under pressure to improve its contact with the slug. Exact manufacturing data are given. (NPO)

10490 HANDLING OF THE COOLING GAS IN NUCLEAR REACTORS. (to AEI-John Thomson Nuclear Energy Co. Ltd.). French Patent 1,222,023. June 7, 1960.

A blow-off device for gas light equipment filled with gas comprises a first connection to a gas feeding device, and a second to a gas discharge line and valves controlling these connections. These valves are controlled to permit, in succession, a plurality of maintenance periods, by a rotatable electrical switching device, each period corresponding to a well-defined azimuth position of this switching device. The start of rotation is controlled by pressure-sensitive means, which close a contact when a well-defined maintenance period ends, in order to change the maintenance conditions in the new position. These periods may be for a fuel-element charge container; blowing-off with fresh gas, evacuating, and filling to the reactor working pressure. (NPO)

10491 NEW MODE OF CONNECTION OF THE SOLID MODERATOR ARRANGED IN THE FORM OF A HEXAGONAL LATTICE IN A NUCLEAR REACTOR. (to Commissariat à l'Énergie Atomique). French Patent 1,222,477. June 10, 1960.

In order to guarantee the alignment of the channels crossing the core of a nuclear reactor constituted by a pile of hexagonal prismatic graphite blocks (these blocks being arranged in a regular hexagonal lattice), the blocks are stacked one above the other in such a way that their central holes form the said channels. Prismatic connecting elements having a star-shaped cross section with three radial branches, each having parallel side faces, are fitted in radial slots grooved into the blocks at their vertical edges so that each element connects three blocks of the same bed and the corresponding blocks of the succeeding bed. The elements of the same level are held at a distance by spacers lying in grooves provided at the horizontal edges of the blocks. Because of the anisotropic expansion of the blocks, the columns must be separated by free spaces. (NPO)

10492 HEAVY WATER MODERATED, ORGANIC LIQUID COOLED NUCLEAR REACTOR. (to North American Aviation, Inc.). French Patent 1,222,856. June 14, 1960.

In a tank of a nuclear reactor, filled with heavy water at about atmospheric pressure, a plurality of vertical, parallelly arranged tubes are immersed, in which tubes the fuel elements are cooled by an organic liquid. The fuel elements arranged inside the tubes have a tubular shape and the coolant flows down over the outside of the said tubular fuel elements and then rises inside them. The tubes are there-

fore closed at their lower ends; a specially shaped plunger sliding near the lower end is actuated by a central rod to control individually the circulation inside each tube. The moderator liquid may be thermally insulated from the tubes by providing double-walled tubes and filling the annular space with helium. (NPO)

10493 THERMAL INSULATION OF THE MODERATOR TANK AND THE CONSTRUCTIONAL ELEMENTS CROSSING THIS TANK IN A LIQUID MODERATED NUCLEAR REACTOR. (to Siemens Schuckertwerke A. G.). French Patent 1,223,077. June 15, 1960.

The thermal insulation of the walls of the moderator tank of a nuclear reactor is provided by a plurality of superposed insulating sheets attached either to the outside or inside of these walls. These sheets are held at such a distance from each other that in the spaces bounded by the sheets, which spaces may be filled with the liquid moderator, thermal exchange by convection is suppressed. This insulation may take the form of a coil of metal strip, e.g., when it is to be attached to the outside of the walls of tubes in which the reactor coolant circulates, the different turns of the coils being kept separated by ribs formed on the metal strips. The concave inner wall of the tank is preferably protected by a plurality of specially shaped sheets. (NPO)

10494 COOLING OR DISCHARGE DEVICE FOR THE DEPLETED FUEL ELEMENTS IN NUCLEAR REACTORS. (to Beteiligungs- und Patentverwaltungs G.m.b.H. and Brown, Boveri & Cie. A. G.). French Patent 1,225,237.

In order to allow attenuation of the radioactivity of the fuel elements in a nuclear reactor before they are discharged, the reactor core tank, filled with fuel elements having a regular geometric shape such as cylinders, spheres, or prisms and having dimensions of about 1 to 200 mm, is connected at its lower end (suitably via a funnel-shaped bottom having its discharge opening central) to a lower container, where the attenuation of the radioactivity of the depleted fuel elements can take place. This container may be separated from the core tank by a suitable shielding wall. The bottom of the container may also be funnel-shaped with a central remotely controlled opening for discharging the fuel elements from the reactor. (NPO)

10495 COMBINED OPERATION TESTING AND SAFETY DEVICE FOR SCRAM RODS OF REACTORS. German Patent 1,065,948. Kerntechnik, 2: 378(Nov. 1960). (In German)

Scram rods are generally held over a reactor core by carrier magnets so that in case of power failure the rods will be inserted into the reactor by their own weight. Occasionally it is desirable to test the operational range of the carrier magnets and the individual scram rods. To do this requires reactor shutdown. The safety device described in the patent application is sturdy and simple to manufacture and is suitable for the testing of scram rods. The principle of the device is schematically represented. (auth)

Power Reactors

10496 (AD-239727) PERFORMANCE POTENTIAL OF NUCLEAR ROCKETS. Robert V. Meghreblian (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). July 6, 1960. 32p. Contract NASw-6.

The ultimate performance potential of nuclear fission rockets is determined with the aid of an idealized reactor model that postulates a nontemperature-limited (gaseous) region of nuclear fuel-bearing material. A generalized system is obtained by incorporating a radiator heat sink in the model. The resulting conclusions that are drawn thus apply directly to low-acceleration (interplanetary) applications. The characteristics of the postulated nuclear engine are found to include a combined high specific impulse (thousands of seconds) with a relatively high engine thrust-to-weight ratio (10^{-3} to 1). Applications to spacecraft result in substantial reductions in total trip time for missions to the near planets over that possible with electric propulsion systems. (auth)

10497 (ANL-6229) EBWR TEST REPORTS. V. M. Kolba, comp. (Argonne National Lab., Ill.). November 1960. 444p. Contract W-31-109-eng-38.

The results of various experiments and tests conducted on the Experimental Boiling Water Reactor are presented. The reported results represent only a part of the over-all experimental work and were selected on the basis of general value to those interested in nuclear science and engineering. Results are given from tests on system components, power output, radiation and flux, control system, physics, dynamics, fuel, and water-chemistry and corrosion. (W.D.M.)

10498 (BMI-1482) VMR CRITICAL-ASSEMBLY STUDIES. Richard A. Egen, Lee H. Bettenhausen, William S. Hogan, David A. Dingee, and Joel W. Chastain (Battelle Memorial Inst., Columbus, Ohio). Dec. 2, 1960. 59p. Contract W-7405-eng-92.

Critical-assembly research was conducted for Advanced Technology Laboratories of the American-Standard Corporation as a part of a program to evaluate the technical and economic feasibility of the Variable Moderator Reactor (VMR) concept. The critical-assembly core consisted of 37 hexagonal stainless-steel fuel-element cans, each containing 61 fuel pins. The fuel pins were 0.485 in. OD aluminum tubing (0.028-in. wall) filled with UO_2 pellets, 0.415 in. in diameter and 1.80% enriched. Fuel pins and elements were arranged in triangular lattices. Core configurations that were combinations of 0.633- and 0.703-in. pin pitches and 5.54-, 5.95-, and 6.34-in. element pitches were investigated. Light water served as the moderator; whereas water, furfural, furfuryl alcohol, and air were used within the fuel elements as coolant-simulating materials. In the various core configurations measurements were made of nuclear parameters related to thermal-flux disadvantage factors, resonance-escape probability, fast effects in U^{238} and U^{235}, and effective neutron temperatures. Critical configurations, reactivity worth of liquid levels, core temperature coefficient of reactivity, and flux and power distributions were also obtained. (auth)

10499 (CEND-83(Vol. III)) ABWR QUARTERLY PROGRESS REPORT, JANUARY 1, 1960–MARCH 31, 1960. VOLUME III. ABWR DESIGN AND DEVELOPMENT. (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). Apr. 15, 1960. 195p. Contracts AT(10-1)-967 and DA-44-192-ENG-11. (IDO-19013(Vol. III)).

The current Army Boiling-Water Reactor program is reviewed. Plant design, core analysis, reactor theory development, and health physics studies are discussed for the Portable Low-Power Plants (PL-1 and PL-2). Plans for installing a PL-2 plant in a snow tunnel at Byrd Station in Antarctica are described. (B.O.G.)

10500 (CF-59-4-88) THERMAL PERFORMANCE OF UO_2 IN EXISTING AND PLANNED REACTORS. W. L. Albrecht (Oak Ridge National Lab., Tenn.). Apr. 20, 1959. 7p.

The thermal characteristics of various reactors fueled with uranium dioxide fuel pellets are listed. (W.L.H.)

10501 (CF-59-6-36) NUCLEAR AND ECONOMIC CHARACTERISTICS OF SEVERAL TWO-REGION HOMOGENEOUS REACTORS. W. W. Rosenthal (Oak Ridge National Lab., Tenn.). June 5, 1959. 12p.

The nuclear characteristics and fuel costs of a number of aqueous homogeneous reactors were estimated. Most of the reactors studied were cylindrical two-region power-breeders variously having between 0 and 300 g/l of thorium in the core and between 500 and 1000 g/l of thorium in the blanket. The results of the calculations, including breeding ratios, fuel inventories, doubling times, and net fuel costs, are summarized. (auth)

10502 (CF-59-6-87) FUEL CYCLE COST FOR AQUEOUS HOMOGENEOUS REACTORS. D. E. Ferguson (Oak Ridge National Lab., Tenn.). June 2, 1959. 25p.

By using a large central fuel-and-blanket processing facility, slurry-fueled aqueous homogeneous reactors can attain an estimated minimum fuel-cycle cost of 1.4 to 1.6 mills/kw-hr; with solution-fueled two-region reactors, a doubling time of 14 years may be obtained at a fuel-cycle cost of 2.0 mills/kw-hr. On-site processing appears desirable only for large power stations made up of reactors designed for short doubling times. For instance, a solution-fueled two-region reactor can attain a 12-year doubling time at an estimated fuel-cycle cost of 1.5 mills/kw-hr at a 2000-Mw electricity station with an on-site processing plant. (auth)

10503 (CF-59-10-79(Rev.)) REACTOR MATERIALS EFFICIENCY. J. W. Ullmann and C. E. Guthrie (Oak Ridge National Lab., Tenn.). Oct. 23, 1959. 14p.

The materials efficiency, in terms of electrical-megawatts per metric ton of natural uranium required for inventory, was calculated for the reactors included in the 10-year proposals and is presented as a function of reactor type and size. (auth)

10504 (CF-60-10-31(Rev.1)) THE HELIUM PURIFICATION SYSTEM FOR THE PROPOSED PEBBLE BED REACTOR EXPERIMENT. C. D. Scott, B. C. Finney, and J. C. Suddath (Oak Ridge National Lab., Tenn.). Oct. 25, 1960. 32p.

A helium coolant side-stream purification system consisting of parallel sections for radioactive and nonradioactive decontamination was designed for the proposed Pebble Bed Reactor Experiment. Primary equipment components are two gas coolers, gas heater, charcoal delay trap, CuO oxidizer, molecular sieve adsorber, and full flow filter. The charcoal delay trap is sized to provide a hold-up of 30 min for Kr isotopes, 6 hr hold-up for Xe isotopes, and 99.9% retention of iodine isotopes resulting in "decontamination factors" varying from 1 for Kr^{85} to 556 for I^{131}. Nonradioactive decontamination will result in a steady state concentration of CO_2 in the coolant of 20.8 ppm or less. Total cost of the system excluding auxiliary equipment and containment is estimated to be $26,690. (auth)

10505 (CF-60-11-90) SPECIFICATIONS FOR FUEL ASSEMBLIES FOR CORE I OF THE EXPERIMENTAL GAS-COOLED REACTOR. J. H. Coobs, E. A. Wick, and R. M. Evans (Oak Ridge National Lab., Tenn.). Dec. 9, 1960. 63p. Contract W-7405-eng-26.

Specifications for the fuel assemblies Experimental Gas Cooled Reactor (EGCR) Core-I were developed for use in procuring the first core loading. A fuel assembly for the EGCR consists of a cluster of seven cylindrical fuel elements spaced and supported within a graphite sleeve. Each fuel element consists of a stainless-steel tube containing a column of hollow UO_2 pellets and having a spacer brazed at the midsection to control the spacing between fuel elements in a cluster. A master specification for the fuel assembly, a supplementary specification for each of the components, and a specification on record keeping during manufacture are included. (auth)

10506 (DLCS-1290102) REACTOR PROTECTION SYSTEM. CORE I, SEED 2. Test Results T-550083. (Duquesne Light Co., Shippingport, Penna.). First issue, Jan. 10, 1961. 10p.

Tests were performed to determine whether or not the Reactor Protection System responded properly to actual or simulated input signals. The system responds to input signals simulating the loss of regulated voltage to the system's magnetic amplifiers, the loss of regulated voltage to two out of four Nuclear Instrumentation Channels, high neutron flux levels, unusual flow conditions, and varying loop status that initiates safety insertions and shutdowns. (W.L.H.)

10507 (DLCS-1290202) REACTOR PROTECTION SYSTEM. CORE I, SEED 2. Section 2. Test Results T-550083. (Duquesne Light Co., Shippingport, Penna.). First issue, Jan. 12, 1961. 6p.

A test was made to determine the time delay between loss of reactor coolant pump power and the tripping of the safety shutdown breaker and rods in relay for safety insertion. The average time delay was 344 msec. The average time delay from the loss of reactor coolant pump power until the opening of the safety shutdown circuit breaker was 348 msec. (W.L.H.)

10508 (DLCS-1550105) EXAMINATION OF COMPONENTS FOR CRUD AND CORROSION 1-B HEAT EXCHANGER HANDHOLE AREA. CORE I, SEED 1. Test Results T-612080. (Duquesne Light Co., Shippingport, Penna.). First issue Oct. 16, 1960. 8p.

The extent and location of corrosion, crud deposits, and defects in the ends of the 1-B heat exchanger after removing the handhole covers were determined. There was no visual evidence of pitting or corrosion inside the ends of the heat exchanger. A radiochemical analysis of a smear sample taken from the inside of number one handhole showed the presence of the following isotopes: Fe^{59}, Co^{58}, Co^{60}, Mn^{54}, Cr^{51}, Hf^{181}, and Zr^{95}. A radiation survey performed in four handholes indicated a maximum level of 1 r/hr. (W.L.H.)

10509 (DLCS-1560107) XENON TRANSIENT TESTS. CORE I, SEED 2, 149.8 EFPH. Section 1. Test Results T-612081. (Duquesne Light Co., Shippingport, Penna.). First issue, Oct. 25, 1960. 41p.

A test was made to determine if there is sufficient excess reactivity in the core to override a peak xenon transient and to obtain data for rod-worth calculations. After 149.8 EFPH's of plant operation on seed 2, there was sufficient excess reactivity to override peak xenon. Criticality during peak xenon was maintained with group III and group IV rods inserted, group I rods withdrawn to ~69 in., and group II rods withdrawn to ~29 in. The override of peak xenon occurred 8 hr and 45 min after shutdown. (W.L.H.)

10510 (DLCS-1600102) INITIAL APPROACH TO CRITICALITY. CORE I, SEED 2. Test Results T-550126. (Duquesne Light Co., Shippingport, Penna.). First issue, June 1, 1960. 11p.

A test was made to bring core 1, seed 2 to the critical condition and to determine the critical rod bank height. Core 1, seed 2 was brought to criticality on a rod bank consisting of the control rods on inverters one and seven at a rod bank height of 24.70 in. (W.L.H.)

10511 (DLCS-2310302) PERIODIC RADIATION SURVEY. CORE I, SEED 1. Section 3. Test Results T-612394. (Duquesne Light Co., Shippingport, Penna.). First issue June 17, 1960. 9p.

Radiation levels inside the concrete enclosures but outside the reactor plant containers after shutdown were determined. Radiation levels in the 1AC, 1BC boiler chamber enclosures and in the reactor chamber enclosure were on the average higher than in previous tests. The highest reading obtained was 7.5 mr/hr and the lowest reading was 0.03 mr/hr; the mean level was 3.76 mr/hr as compared to 1.37 mr/hr in previous tests. (W.L.H.)

10512 (DLCS-2350101) DETERMINATION OF WATER REQUIREMENTS FOR SHIELDING IN THE REACTOR PIT OF CANAL DURING OPERATION. CORE I, SEED 1. Test Results T-641307. (Duquesne Light Co., Shippingport, Penna.). First issue, June 6, 1960. 15p.

A test was made to determine radiation levels in the reactor pit and canal walkways with the reactor pit filled to various levels. Temperatures at several locations on the floor of the reactor pit while the reactor was at power were also measured. Draining all shielding water from the pit while the reactor was at approximately 39% of full power did not result in a radiation hazard on the canal walkways. When the reactor pit was completely drained the highest radiation levels were found above the outside edge of the reactor dome approximately 25 ft from the pit floor. The temperature of selected bolts and the surrounding concrete at the base of the reactor dome did not increase when all the water was removed from the reactor pit. (W.L.H.)

10513 (DLCS-3070101) PRIMARY PLANT SELF-ACTUATED RELIEF VALVE OPERATION. CORE I, SEED 1. Test Results T-641100-B. Section 1. (Duquesne Light Co., Shippingport, Penna.). First Issue, Oct. 7, 1960. 11p.

Tests were made to insure the reliable operation of the self-actuated pressurized steam relief valves and the self-actuated reactor water relief valves within the prescribed pressure settings. Of the six valves tested, four operated within the prescribed operating pressure limitations. Since the actual popping pressure of the other two valves was close to the prescribed operating pressure limitation, no adjustments were made. (W.L.H.)

10514 (DLCS-3450102) STATION PERFORMANCE DURING AN UNSCHEDULED POWER TRANSIENT. CORE I, SEED 2. Test Results T-643730. (Duquesne Light Co., Shippingport, Penna.). First issue, Aug. 23, 1960. 9p.

During an unscheduled power transient, caused by a safety shutdown at full power, the response of the plant was sufficient to prevent any of the operating parameters from exceeding their limitations. (W.L.H.)

10515 (DLCS-3570301) REACTOR PLANT CONTAINER INTEGRITY TEST. CORE I, SEED 2. Section 3. Test Results T-643733. (Duquesne Light Co., Shippingport, Penna.). First issue, June 6, 1960. 23p.

The interconnections between the chambers and all pipe penetrations of the reactor plant container were inspected for signs of damage or rupture. The conditions were satisfactory. A positive bolt tightness as specified in the test procedure existed on the container hatches, reactor dome, and container stop joints. (W.L.H.)

10516 (DLCS-3620101) REACTIVITY LIFETIME. CORE I, SEED 2. Test Results T-612118-C. (Duquesne Light Co., Shippingport, Penna.). First issue, Dec. 13, 1960. 13p.

Core I, Seed 2, was subjected to rapid reactivity depletion by operating the station at full power for extended periods of time to obtain pertinent plant operating data for an evaluation of core design and lifetime performance. The station was operated at 100% power, with a gross output of 67 Mw(e) for 731 EFPH. Two shutdowns occurred during this period: one scheduled and one unscheduled, caused by the tripping of turbine throttles during the weekly throttle trip check. (B.O.G.)

10517 (DP-535) HEAVY WATER MODERATED POWER REACTORS PROGRESS REPORT AUGUST 1960. D. F. Babcock, R. R. Hood, and L. Isakoff (Du Pont de Nemours (E. I.) & Co. Atomic Energy Div., Wilmington, Del.). November 1960. 42p. Contract AT(07-2)-1.

At the end of August 1960, construction of the Heavy Water Components Test Reactor (HWCTR) was 40% complete. Fabrication of the two main D_2O circulating pumps for the facility was completed. Experimental data were obtained in the Process Development Pile on the magnitude of the Dancoff shielding effect in clusters of uranium metal rods in D_2O. Work continued on the development of satisfactory billet designs for coextrusion of thin-walled Zircaloy-clad tubes of uranium metal for irradiation tests. The irradiation of an assembly of Zircaloy-clad tubes of swaged uranium oxide continued uneventfully at Savannah River. (For preceding period, see Report DP-525). (auth)

10518 (DPR/INF/253) DEVELOPMENTS IN GAS COOLED REACTORS. William Cook (United Kingdom Atomic Energy Authority, London). April 1960. 5p.

Excerpts from a talk are presented. The Advanced Gas-cooled Reactor and the very high temperature Dragon reactor are described as the next two steps to be taken toward more economical nuclear power. (T.R.H.)

10519 (GAI-1512) RELIABILITY STUDY. EQUIPMENT AND COMPONENTS IN NUCLEAR POWER PLANTS (A FINAL ENGINEERING REPORT). (Gilbert Associates, Inc. Nuclear Energy Dept., Reading, Penna.). July 1960. 391p. Project No. 6185. Contract AF30(602)-2017. (AD-241088).

The operating experience at five nuclear power plants is reviewed and analyzed. The various events recorded are categorized according to the nature and severity of the event and by the type of equipment or component involved. The problems encountered are discussed by type category, and certain general and specific recommendations concerning reliability improvement are made. More than 1800 incidents are reviewed. Of these, nearly 300 caused unscheduled loss of load by the plant involved. Most of these unscheduled load-loss failures and many other occurrences are discussed in the report. The five nuclear power plants included in the study are as follows: Experimental Boiling Water Reactor (EBWR), Shippingport Atomic Power Station, Stationary Medium Power Plant No. 1 (SM-1), Stationary Low Power Plant No. 1 (SL-1), and Vallecitos Boiling Water Reactor (VBWR). The most significant area of trouble has been instrumentation and control, particularly in the nuclear portion. Among more conventional apparatus, the turbine-generator, piping, electrical auxiliary equipment, instruments, controls, and valves accounted for many maintenance problems and failures. These problems are discussed, and corrective or preventive measures are recommended. An over-all program aimed at improving the reliability of nuclear power plants is presented in terms of responsibilities of the sponsoring agency, administrator, designer, engineer, manufacturers, erectors, and operators. (auth)

10520 (GEAP-3602) SOME CONTROL ROD APPLICATIONS AND OPERATING EXPERIENCE IN POWER REAC-

TOR ENVIRONMENTS. H. E. Williamson (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Dec. 14, 1960. 12p. Contract AT(04-3)-189.

Information obtained in a survey of control-rod applications and operating experience is reported. This survey covered the Army Nuclear Power Program, the Organic-Moderated Reactor Experiment, the Yankee Atomic Power Plant, the Shippingport Pressurized-Water Reactor, and the Argonne Experimental Boiling-Water Reactor. (auth)

10521 (HW-58893) REACTIVITY EFFECTS ASSOCIATED WITH THE CHANGE IN PRIMARY COOLANT QUALITY IN PRTR. R. E. Peterson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). January 16, 1959. 6p.

The PRTR high-pressure D_2O piping systems are expected to leak due to numerous seals in the top and bottom face piping. It is expected that some H_2O contamination will occur in the recovered D_2O. Since it is desirable to return D_2O leakage to the primary system without further treatment, it is necessary to know the effect of H_2O contamination of the primary system on the reactivity and neutron spectrum of the PRTR. The reactivity change associated with increasing H_2O fraction in the primary coolant in the spike enriched PRTR is relatively small to concentrations of the order of 20 mole %. There is no apparent loss to 10 mole % H_2O and only 2 mk, at 20%. Although the presence of H_2O in the primary coolant has a small effect on reactivity, it will cause a change in the neutron spectrum in the fuel. This is evident from the rise in resonance escape probability for increasing H_2O concentration. It was determined that the fractional change in the proportion of epithermal neutrons in the spectrum in the fuel is nearly the same as the fractional change in H_2O concentration in the coolant for small additions of H_2O. (W.L.H.)

10522 (HW-60845) GAMMA HEATING IN PRTR GAS LOOP. J. J. Regimbal (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 23, 1959. 6p.

The in-reactor portion of the test section of the PRTR gas-cooled loop facility is considered to consist of two concentric Inconel-X tubes. A study was made of the specific power generation in the tubes by absorption of energy from direct gammas and gammas produced by neutron captures in the Inconel. The total specific-power generation in each of the Inconel tubes from direct and capture gammas was found to be 1.0 watt/g Inconel. (W.L.H.)

10523 (IDO-28552) IN-PILE TESTS OF GCRE-IB PROTOTYPE FUEL ELEMENTS. ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. Interim Report covering work performed in 1958-1959. H. T. Watanabe, J. E. Janne, and W. D. Wilson (Aerojet-General Nucleonics, San Ramon, Calif.). Oct. 1960. 76p.

A program has been set up to develop and evaluate a ceramic-core pin-type fuel element for the Army Gas-Cooled Reactor Systems Program. The method being used is to irradiate full-scale fuel elements in test loops (BRR-GCR, GETR, and ETR) under known reactor conditions. The experiment designated IB-IT, which is described, was the first in a proposed series of tests. Two prototype elements were run in a gas-cooled loop in the Battelle Research Reactor. Average power generation of the elements was 30 kw. Irradiation times ranged from 35 to 165 hr. Results of the tests indicated that the enrichment of UO_2 in the outer circle of pins is close to the optimum value. The use of a finned surface on one of the test elements did not significantly increase the heat-transfer properties. No significant distortions occurred in the elements as a result of thermal cycling. (auth)

10524 (IDO-28563) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. Monthly Progress Report for September 1960. (Aerojet-General Nucleonics, San Ramon, Calif.). Sept. 1960. 109p. Contract AT(10-1)-880.

NRTS Operations. Testing of the GCRE with the plate type fuel elements was concluded and this core was removed. The pin type fuel elements were loaded and critical experiments and zero-power tests begun. ML-1 operations are summarized. ML-1. Fabrication of the ML-1 package progressed satisfactorily. The tube bundle assembly was leak tested and control blade mount assemblies were completed. Confirmatory measurements for the shield were made at ORNL. Fuel Element Development. In the IB-2T-1 in-pile test, long-lived fission product activity was noted in the loop gas after increase of outlet gas temperature to 1300°F. Materials evaluation results included tensile properties of Hastelloy-X at 1750°F and tube burst tests at 2100 to 2300°F. Compositions and tensile properties for modifications of Hastelloy-X are given. Advanced Reactor Systems Project. Evaluations of advanced nuclear power plants were made to select a system for an advanced mobile power plant concept. Helium and air were studied as coolants, and closed turbine cycles were compared with open-cycle two-fluid systems. Gas Turbine Test Facility. Results of test runs are discussed. (T.R.H.)

10525 (NAA-SR-Memo-2669) CALCULATION OF THE ISOTHERMAL TEMPERATURE COEFFICIENT OF REACTIVITY FOR THE HALLAM REACTOR CORE. R. J. Doyas (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 22, 1958. 15p.

The isothermal temperature coefficient for the Hallam nuclear facility reference design core was calculated. It was found to be positive and decreases very slowly with increasing temperature. The value of $\partial\rho/\partial T$ at 450°C is $+1.10 \times 10^{-5}\ \partial K_e/K_e/°C$. It does not go negative at any temperature likely to be reached in normal operation. (T.R.H.)

10526 (NAA-SR-Memo-3836) HNPF INPILE POISON RING TEST NO. 2. L. B. Copeland. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 26, 1959. 27p.

Tests were conducted in the Sodium Reactor Experiment (SRE) to obtain temperature and neutron flux measurements that were required for calculating the heat generation rates and thermal conductivity of rare earth oxide control elements that are proposed for use in the Hallam Nuclear Power Facility. The maximum ΔT on a horizontal plane between the test assembly and the sodium coolant was 633°F. The maximum ΔT across an absorber ring was 331°F in the eccentric ring while the maximum ΔT across an absorber ring wall of the concentrically fixed rings was 271°F. Pile γ heating produced a temperature of 950°F on the Zircaloy ring while the sodium coolant was 820°F at this level. Results of neutron flux measurements are presented graphically. (J.R.D.)

10527 (NAA-SR-Memo-5718) EXPERIMENTAL EVALUATION OF A TEST CONTROL ROD INTERNAL TO A FUEL ELEMENT IN THE STANDARD CONFIGURATION OF THE OMR CRITICAL EXPERIMENT. L. S. Beller (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 20, 1960. 22p.

The effectiveness of a test control rod internal to and concentric with a cylindrical fuel element was evaluated relative to the standard 12-plate fuel elements and standard control rods of the initial loading of the Piqua Critical Ex-

periment. The test control rod was calibrated by period-measurement techniques in the central lattice position at two different loadings. (W.D.M.)

10528 (NAA-SR-Memo-5738) ISOTHERMAL TEMPERATURE COEFFICIENT OF THE PIQUA OMR CRITICAL ASSEMBLY. L. A. Mountford (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 28, 1960. 12p.

The isothermal temperature coefficient of a 6-in. triangular lattice of cylindrical fuel elements over the temperature range of the OMR Critical Facility was measured. The results are shown with theoretical calculations for comparison. Two calculations of the temperature coefficient of a Piqua-type core were made. Both are in disagreement with experimental values over most of the temperature range of the measurement. (W.L.H.)

10529 (NASA-TN-D-675) AN OPTIMIZATION OF POWERPLANT PARAMETERS FOR ORBITAL-LAUNCH NUCLEAR ROCKETS. Paul G. Johnson and Roger L. Smith (National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.). Feb. 1961. 47p.

Performance of orbital-launch nuclear rockets was computed for ranges of gross weight, mission energy, and hydrogen temperature to show the effects of variations in hydrogen pressure, reactor power, and reactor flow area. Spacecraft performance is shown to be relatively insensitive to variations in design-point pressure or power. Pumped systems give maximum residual load at reactor-exit pressures of 100 to 300 lb/sq in. absolute and powers of 300 to 1500 Mw for gross weights from 30,000 to 150,000 lb. Reductions in pressure or power by factors of 2.5 to 5.0 correspond to only a 5% reduction in residual load. Pressurized systems optimize at 30 to 35 lb/sq in. absolute and 80 to 400 Mw for the same gross-weight range, with 95% performance corresponding to pressure or power reduction by factor of 1.5 to 2.5. (auth)

10530 (NDA-2131-28) HEAVY WATER-MODERATED POWER REACTOR PROGRAM. Monthly Progress Report for Period Ending October 31, 1960. J. H. Hutton (Nuclear Development Corp. of America, White Plains, N. Y.). Nov. 10, 1960. 11p. Contract AT(30-1)-2303(1X).

Several additional experiments were conducted in PLATR to determine the effect of nonflat, axial neutron-flux distribution. The results indicate that < 5% variation from the peak to the test section ends is satisfactory. The 37-rod clusters were installed in PLATR on an 11.1-in. lattice pitch. Approximately 18 experiments will be run with this cluster size. The 19-rod test section for Columbia University entered the detail design stage. The functional specification and layout were approved and issued. (auth)

10531 (NMI-7231) POWER REACTOR PROGRAM PROGRESS REPORT TO E. I. du PONT de NEMOURS AND COMPANY FOR THE PERIOD AUGUST 1, 1960 THROUGH AUGUST 31, 1960. S. Isserow, A. M. White, H. F. Sawyer, W. L. Larson, D. S. Kneppel, W. J. Richmond, P. R. Smoot, H. M. Green, and W. B. Tuffin (Nuclear Metals Inc., Concord, Mass.). Oct. 4, 1960. 35p. Contract AT(30-1)-1565.

The core design for a demonstration set of outer tubes includes the rear end shape and thickened inner sleeve of tube 88 and a slight modification of the front end shape used for tube 99. Three prototype inner tubes were extruded. Work to determine cooling rates in β treatment was initiated and results were obtained for inner thin-walled tubes, outer thin-walled tubes, and thick-walled tubes. Processing two unenriched VBWR tubes with uranium–1.5 wt.% molybdenum cores was held up while optimum conditions of heat treatment are established. A prototype enriched, unalloyed uranium VBWR tube was extruded. A uranium–1 wt.% silicon billet core was cast and epsilonized for fabrication of additional specimens for capsule irradiation. The experimental work to determine tensile, stress-rupture, and creep properties of unalloyed dingot uranium and uranium–1.5 wt.% molybdenum was completed. Three additional stainless steel–Zircaloy joints were extruded but not evaluated. (For preceding period see NMI-7230.) (W.L.H.)

10532 (NP-9285) ADVANCED COURSE ON HEAT EXTRACTION FROM BOILING WATER POWER REACTORS AND ASSOCIATED DYNAMIC PROBLEMS. [Pt. I]. Organized at the Netherlands'-Norwegian Reactor School, Kjeller, Norway. 17th August–29th August, 1959. J. Asyee, L. W. Fromm, L. H. Prytz, V. O. Eriksen, T. Havie, R. Chr. Skaardal, J. Fleck, E. Jansen, and B. Winther (Netherlands'-Norwegian Reactor School. Advanced Summer Inst., Kjeller, Norway). 256p.

A series of lectures was presented including topics on history and current status of boiling water reactor development, physics of boiling water reactors, BORAX and SPERT experiments, reactor transfer functions, small oscillations in boiling water reactors, hydraulic model of boiling reactor dynamics, boiling experiments in connection with the Halden core, general types of power cycles and plant components, power plant control, principles of analogue and digital computers, control analysis with a digital computer, and economics of nuclear ship propulsion. (W.D.M.)

10533 (NP-9286) ADVANCED COURSE ON HEAT EXTRACTION FROM BOILING WATER POWER REACTORS AND ASSOCIATED DYNAMIC PROBLEMS. [Pt. II]. Organized at the Netherlands'-Norwegian Reactor School, Kjeller, Norway. 17th August–29th August, 1959. P. A. Lottes, J. F. Marchaterre, and M. Petrick (Netherlands'-Norwegian Reactor School. Advanced Summer Inst., Kjeller, Norway). 231p.

A series of lectures was presented on heat extraction from boiling water power reactors including topics on Heat Transfer, Two-Phase Pressure Drop, The Prediction of Steam Volume Fractions, Critical Heat Flux or Burnout, Calculation Procedures for Boiling Systems, Thermal and Hydraulic Design Procedures for Boiling Water Reactors, and Properties of Light and Heavy Water. (W.D.M.)

10534 (NP-9534) BASIC ASSUMPTIONS FOR NUCLEAR POWER ESTIMATES IN EUROPE. (European Nuclear Energy Agency, Paris). 1960. 35p.

A 1958 estimate is revised in the light of technology advances and program changes of the past 2 years. Capacity of stations completed by 1966 is about 6000 Mw(e), contributing only 5% of electric production and 3% of total estimated installed capacity in 1966. Capital costs until 1966 will fall to $280/kw(e) for gas-cooled and $250/kw(e) for light-water reactors. Fuel costs per kg of natural uranium will be about $175 and $290 for enriched. Total capital costs by the end of 1966 will be $\$2.2 \times 10^9$, total fuel expenditures $\$880 \times 10^6$. (T.R.H.)

10535 (ORNL-2936) ASSEMBLY OF FIFTY PROTOTYPE FUEL ELEMENTS FOR THE EXPERIMENTAL GAS-COOLED REACTOR. E. A. Wick and R. L. Heestand (Oak Ridge National Lab., Tenn.). Dec. 23, 1960. 91p.

The fuel assembly for the Experimental Gas-cooled Reactor consists of a cluster of seven fuel elements supported in a graphite sleeve. Following the early design work, certain problems associated with procurement and assembly of

the components remained to be identified and resolved. Sufficient components for fifty fuel assemblies of the Title I design were procured commercially in accordance with detailed specifications, and were assembled in a pilot plant operation. All components and completed assemblies were inspected carefully. The fabricability of the design was confirmed, and several important modifications in the specifications and design were developed. Reliable cost estimates also were obtained on sufficient components for a reactor loading. In addition, process specifications were developed for the welding and brazing operations. (auth)

10536 (TID-6605) EVALUATION OF ORGANIC COOLED REACTORS. Final Report. J. R. Powell, ed. [(Brookhaven National Lab., Upton, N. Y.)]. Dec. 15, 1958. 84p.

Power costs were calculated for organic-cooled reactors moderated by either organic, graphite, or heavy water. All designs were normalized to the same operating conditions so that the only variable costs were inventory, burn-up, fuel fabrication, and reactor structure costs. Comparison of the optimum designs indicated the power cost of the heavy-water design to be approximately 0.4 mill/kw-hr cheaper than the organic, and the graphite to be approximately the same as organic. However, it was recommended that development work be concentrated on a large organic-moderated reactor. The potential savings using heavy water are a small part of total power costs, and the feasibility of large organic-moderated reactors should be proved before attempting the much more complicated heavy water-organic reactors. Investigation of the heavy-water design should continue with further refinement of the cost estimates. The heavy water-organic reactors considered in this study will probably not go critical on natural uranium, and would not be optimum in cost. They can undoubtedly be designed to use natural uranium, but power density may have to be lowered, increasing power costs. If feasible oxide fuel elements capable of 10,000 Mwd/ton can be devised, which cost about the same as the present metallic elements, about 2 mills/kw-hr would be saved in fuel-element fabrication charges. (auth)

10537 (TID-7595) NUCLEAR SUPERHEAT MEETING NO. 1, SEPTEMBER 21 to 23, 1959. [Held at San Jose, Calif.]. (Chicago Operations Office, AEC). Nov. 3, 1959. 48p. (COO-260)

The first of a series of AEC sponsored meetings with Nuclear superheat contractors was held in San Jose, Calif., on Sept. 21-23, 1959. These meetings are in the nature of technical seminars with particular emphasis on engineering data that has been developed and current problems and proposed methods of solving them. However, since this was the first such meeting, some time was spent presenting contractor plans, reactor and test facility designs, and schedules. A summary of the highlights follows: General Electric Company: The presentation involved a detailed explanation of the Superheat Advanced Demonstration Loop in the Vallecitos Boiling Water Reactor, operational data obtained to date, and future experiments. Combustion Engineering, Inc: The presentation involved a description of the BONUS project and design considerations for a 200 Mw(e) integral boiling-superheat reactor. Allis-Chalmers Manufacturing Company: This presentation described the Pathfinder plant design and the backup research and development program. This reactor is well along in the design and development stage. Argonne National Laboratory: This presentation described in detail the EBWR superheat experiment, which is completely designed but has not yet run due to safeguards considerations. ANL plans to run this experiment after the 100 Mw modifications are completed (scheduled for Sept. 1960). The BORAX-V project which is currently being constructed was described. This plant is scheduled to begin full power operation with a superheater core on July 1, 1961. (auth)

10538 (TID-7596) NUCLEAR SUPERHEAT MEETING NO. 2, APRIL 7 AND 8, 1960 [AT] DUNEDIN, FLORIDA. (Chicago Operations Office, AEC). June 30, 1960. (COO-261).

The second of a series of AEC-sponsored meetings with nuclear superheat contractors was held in Dunedin, Fla., on April 7 and 8, 1960. These meetings are in the nature of technical seminars with particular emphasis on engineering data that have been developed since the last meeting. A summary of the highlights follows: Combustion Engineering, Inc: The presentation involved a detailed explanation of the preliminary reference design for a 200 Mw(e) integral boiling-superheating reactor which produced steam at 1050°F and 1200 psia. The reference design serves as a guide to the experimental research and development program and is based on advanced technology. Design parameters that were investigated prior to arriving at the current reference design were discussed. The initial reference design consisted of a central boiling region and a peripheral superheating region. However, the reference design has since been modified and now consists of a central combination boiling-superheating region surrounded by a boiling region. Double annuli fuel elements cooled with boiling on their outermost surface and by steam on their three inside surfaces are used in the center portion of the core. Fuel cycle cost studies were performed with both a central and peripheral superheat location. No clear categorical advantage was found for either location. Current indications are that the central region superheater may be advantageous for large reactors and the peripheral region may be advantageous for small reactors. Allis-Chalmers Manufacturing Company: The presentation consisted of a description of the Pathfinder plant and the research and development program on low enrichment superheat fuel elements. Allis-Chalmers has set a target of developing a low enrichment superheater fuel element for insertion in the third Pathfinder core (1963). Recent design changes at the Pathfinder plant consist of substituting zirconium for aluminum as a cladding material for the boiler fuel elements and incorporating control-rod tube gangs that will be positioned in selected superheater fuel process tubes. Argonne National Laboratory: The in-pile superheating loop for EBWR is scheduled to be installed in the fall of 1960. The preliminary results of a multiple nuclear reactor plant economic study for a 300 Mw(e) unit, consisting of three boiling water reactors in parallel and two boiling water reactors with a nuclear superheater in series, were discussed. The BORAX V project, which is currently being constructed at the National Reactor Testing Station, was described. Construction was about 15% complete as of Apr. 1, 1960. Initial criticality with a boiling core is scheduled to begin Jan. 1961, and full power operation with an integral boiling-superheating core is scheduled for July 1961. General Electric Company: Economic analyses of fuel cycle costs for a 225 Mw(e) integral boiler-superheater core were discussed. The results indicate that the fuel cycle cost differential between central, annular, and peripheral superheat locations for an optimized core is about 0.1 mill/kw-hr. The cost difference in an optimum configuration and the worst case for a given superheater location was found to be 0.9 mill/kw-hr. Economic studies of a 300 Mw(e) separate nuclear superheater plant were discussed. The fuel cycle cost advantage of superheat over

a saturated steam cycle is about 0.2 mill/kw-hr. The capital cost advantage is about 1 mill/kw-hr. The optimum nuclear superheat plant temperature is lower than that of a conventional plant and is in the range from 850 to 900°F. The SADE loop in VBWR has been shut down since Sept. 23, 1959, for VBWR modification for higher power operation. Work on a conceptual design of a mixed spectrum integral boiling water reactor consisting of a fast, unmoderated, superheat zone surrounded by a thermal, boiling water zone has recently been initiated and was briefly discussed. Atomics International: The presentation involved a brief description of an AI study to evaluate the technical feasibility and economic incentive of zirconium hydride as a moderator for a superheater for a 300 Mw(e) integral boiling reactor plant. (auth)

10539 (TID-11042) SOME POSSIBILITIES FOR REDUCING ORGANIC REACTOR COOLANT COSTS. R. O. Bolt, J. G. Carroll, W. W. West, and W. W. Hanneman (California Research Corp., Richmond, Calif.). May 31, 1960. 20p. Contract No. AT(11-1)-174, Report No. AC-3.

Since cooling of nuclear reactors with organic fluids has proved technically feasible, a study of means to reduce coolant costs is justified. Reprocessing of radiolyzed polyphenyl tars to make coolant feed is one approach of interest. Another is the recovery of salable materials from selected radiolyzed coolants. Cracking-hydrogenation reactions were chosen for study under the first approach. Ortho- and meta-terphenyls were used as model compounds whose reactions are typical of those expected from higher polyphenyls in radiolytic tars. The terphenyls were treated with hydrogen and a number of catalysts under various pressure and temperature conditions. Scission of the ring-to-ring linkages proved possible with only minor attack on the aromatic unsaturation. Thus this approach is promising for producing coolant feed material and is deserving of further work. In research on the salable product approach, mixtures of aromatic ethers and phenols with benzene were exposed to γ radiation. The kind and amount of products were determined by mass spectrometric analyses. It was shown that polyphenyl ethers, possibly useful as high-temperature lubricants, hydraulic fluids, etc., can be prepared in this manner. Thus, by controlling the constituents of the coolant charge, specific useful products might be produced. The economic recovery and sale of these would offset, in part, coolant costs in a reactor plant. Additional work on this approach is desirable. (auth)

10540 (TID-11322) RADIATION SURVEY OF THE REACTOR VESSEL HEAD. CORE I, SEED 1. Test Results RNI-39. (Duquesne Light Co., Shippingport, Penna.). First issue, Oct. 24, 1960. 23p. (DLCS-3050101; DLCS-3050102; DLCS-3050103).

A detailed radiation survey was made of the reactor vessel head to determine both the magnitude and identity of the radiation at specific intervals after shutdown. A gamma survey of the vessel head indicated radiation levels ranging from a low of 30 mr/hr at 8 ft above the head and outside the mechanism cage to a high of 1.2 r/hr at the thermocouple penetrations on the mechanism port housings. The data obtained with the 100-channel analyzer show the probable presence of Co^{60}. (W.L.H.)

10541 (TID-11462) ACTIVATION AND TRANSPORT OF LONG-LIVED CORROSION PRODUCTS. CORE I, SEED 1. Test Results T-641107. (Duquesne Light Co., Shippingport, Penna.). First Issue, Oct. 24, 1960. 12p. (DLCS-1980109; DLCS-1980110; DLCS-1980111).

An investigation was made to provide information on the mechanisms of activation and transport of corrosion products under the reference water conditions of PWR. The variation of the concentration of nuclides associated with the crud is shown. The data indicate increased levels of specific activity of the various activation products when the plant is heated up and brought to power after an extended cold lay-up. These levels diminish somewhat as the plant is operated. (W.L.H.)

10542 (YAEC-106) THERMAL DESIGN ASPECTS OF THE YANKEE FIRST CORE FUEL ROD. E. A. McCabe, Jr. (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh and Yankee Atomic Electric Co., Boston). November 1960. 62p. Subcontract No. 1 of Contract No. AT(30-3)222.

The thermal design of the Yankee Core-1 fuel rod is presented, and the factors that affect its performances are discussed, with particular emphasis on the pellet-clad void. The equations and methods used to estimate the temperature distributions, fission-gas release, and internal gas pressure are given. (auth)

10543 EFFECT OF ELECTRICAL AUGMENTATION ON NUCLEAR ROCKET FLIGHT PERFORMANCE. Edwin R. Berry (Convair, Fort Worth, Tex.). ARS Journal, 31: 92-4(Jan. 1961).

A specific example of the transmission of electrical power from a propulsion reactor to the working fluid is evaluated. Such a scheme increases the specific impulse of a nuclear rocket but imposes a dead weight increase for electrical equipment. In the case studied thermionic converters produce an arc discharge in the hydrogen working fluid. Arbitrary and approximate assumptions are made, but the effect of them on the results is not considered significant. Other working fluids were considered: Li, LiH, NH_3, and H_2O. It appears that unless heat-to-power conversion equipment lighter than 0.005 lb/ekw can be developed, electrical augmentation offers no advantage. (T.R.H.)

10544 SWEDISH REACTOR IN THE VICINITY OF STOCKHOLM. H. Tham. Atom u. Strom., 11: 95-9(Nov. 1960). (In German)

After a survey of the reactor program planned for Sweden and the aims of the present development, the reactor being constructed in the vicinity of Stockholm is described. This project unites the plans of R3 and Adam. The reactor should produce about 55-Mw heat power and 10-Mw electrical power and can be improved later. (tr-auth)

10545 THE BEST TEMPERATURE FOR THE REGENERATIVE WATER-HEATING SYSTEM OF NUCLEAR POWER STATIONS HAVING WATER-COOLED AND WATER-MODERATED REACTORS (WWPR). Yu. D. Arsen'ev. Atomnaya Energ. 10: 19-25(Jan. 1961). (In Russian)

The "base point" method was used for determining the optimum temperature for regenerative water heating t^{opt} corresponding to the minimum calculated costs for electric energy (cent/kw h). It is shown that for a power plant with a water-moderated reactor the t^{opt} is close to the maximum steam parameter at the first turbine outlet. (tr-auth)

10546 OPTIMIZATION OF COOLING MEDIUM IN ADVANCED GAS-COOLED REACTORS. H. Benzler (Deutsche Babcock & Wilcox Dampfkessel-Werke AG, Oberhausen, Germany). Atomwirtschaft, 5: 518-22(Nov. 1960). (In German)

In order to choose the most suitable gas for reactor cooling the gases under consideration must be examined and mutually compared with respect to their neutron absorption,

activation, chemical reactivity, tendency to leakage, thermal properties, and price. After a discussion of the various properties, basic viewpoints on the establishment of the gas pressure, flux, and inlet temperature are treated. The cooling on part load and after shutdown, as well as problems of natural circulation and inversion of the cooling medium, are considered. (auth)

10547 NUCLEAR PROPULSION FOR MERCHANT SHIPS. Sherwood L. Fawcett (Battelle Memorial Inst. Columbus, Ohio). Battelle Tech. Rev., 10: 3-7 (Jan. 1961).

Some of the problems involved in the maritime application of nuclear propulsion are discussed briefly, especially those of economic and research and development aspects. Fueling stations are considered. (D.L.C.)

10548 SIZEWELL NUCLEAR POWER STATION. Brit. Power Eng., 2: No. 2, 85-6(Jan. 1961).

The Sizewell Nuclear Power Station is described. It will supply 580 Mw from two reactors. It differs from other British nuclear power stations in that the reactors are in one building, allowing certain common equipment and facilities. The spherical site-welded pressure vessel will have 4-in. walls and an inside diameter of 63 ft 6 in. The fuel elements are an improved type with the magnox cans extended with polyzonal multistart helical threads to permit an increase in outlet gas temperature. A tabulation of technical data is included. (T.R.H.)

10549 CONCRETE FOR BIOLOGICAL SHIELDING OF POWER REACTORS. Emanuele Fumagalli (ISMES, Bergamo, Italy). Energia elettrica, 37: No. 2, 9p.(1960). (In Italian)

The physics of biological shielding for power reactors is discussed, and concretes for this purpose are described. The selection of materials is treated. Specific types of concretes described are barite, magnetite, and heterogeneous. (T.R.H.)

10550 ECONOMIC STUDY AND OUTLOOK FOR NUCLEAR NAVAL PROPULSION. Francisco Pascual Martínez. Energia nuclear (Madrid) IV: No. 15, 20-23 (July-Sept. 1960). (In Spanish)

Some economic considerations are presented on the application of nuclear energy for marine propulsion. A comparison is made between the present cost of nuclear propulsion and the cost of conventional systems installed in analogous ships. Factors contributing toward the cost of nuclear fuels are reviewed. Then American and British studies on the comparative costs of nuclear and conventional marine propulsion are examined. (J.S.R.)

10551 STATISTICAL ANALYSIS OF THE TEMPERATURE DISTRIBUTION IN NUCLEAR POWER REACTORS. Agustin Alonso. Energia nuclear (Madrid) IV: No. 15, 34-43 (July-Sept. 1960). (In Spanish)

The statistical method proposed by APDA was applied to the study of temperature distribution in a hypothetical reactor moderated by heavy water, cooled by organic liquid, and fueled by natural UO_2. An aluminum alloy is used as cladding material. The results obtained are translated to the possibility of cladding rupture. For this it was necessary to calculate a bidimensional statistical distribution. (J.S.R.)

10552 HEAT TRANSFER FROM A BOILING WATER REACTOR. Rudolf Pruschek. Energie, 12: 41-7(Feb. 1960).

A study was made for a dual-cycle boiling-water reactor (similar to the Dresden BWR) of the possibility of heat dissipation in a natural convection system as well as of the temperature relation in the fuel element. In addition, the permissible heat-flux density in a pressure loop system was established. (T.R.H.)

10553 METHOD TO IMPROVE THE EFFICIENCY OF NUCLEAR ELECTRIC PLANTS BY MEANS OF THE REDUCTION OF THE HUMIDITY IN THE TURBINE. Giovanni Chiantore and Francesco Baldo. Ing. nucleare, 3: 151-63 (July-Aug. 1960). (In Italian)

A feature common to nearly all types of nuclear electric plants is the generation of saturated or slightly superheated steam. As a result, all or a substantial fraction of the steam expansion occurs in the wet zone. Methods investigated or considered for the reduction of the moisture throughout the expansion zone are examined. These include internal separation, automatic external purges, and intermediate superheating using either bleed or live steam. A comparison was then made between the effects of each method or a combination of them on the efficiency. The methods best suited for each individual type of nuclear installation are indicated. (tr-auth)

10554 ON THE FAST BREEDER REACTOR. Shoji Nomoto, Yorio H. Tomioka, and Tomoo Nakamura (Japan Atomic Energy Res. Inst.). J. At. Energy Soc. Japan, 2: 622-37(1960). (In Japanese)

A review is presented of the physical characteristics and present status of the fast breeder reactor. The neutron energy distribution, neutron spatial distribution, power distribution, and some consideration of the design of the fast reactor are described in order to evaluate the breeding potentiality. The kinetics and control characteristics of the fast reactor, such as the prompt neutron life time, effective delayed neutron fraction, reactivity change due to temperature change, and power instability are discussed. The experimental results with critical assemblies are summarized. (auth)

10555 DYNAMIC ANALYSIS OF A BRITISH TYPE GAS COOLED REACTOR DURING LARGE POWER CHANGES. I. THE METHOD OF ANALYSIS AND OUTLINE OF RESULTS. Junichi Miida (Atomic Energy Research Inst., Tokyo), Nobuhide Suda, Tetsuo Takeuchi, and Toshio Irie. J. Atomic Energy Soc. Japan, 2: 742-9(Dec. 1960). (In Japanese)

A study by use of an analog computer of the dynamic characteristics of a British type gas-cooled reactor during its large power changes is described. It is assumed that power changes are caused by changing the cooling gas flow rate under the condition that the outlet gas temperature is kept constant by a temperature control system. This study is mainly concerned with the performances of the reactor with positive moderator temperature coefficient of reactivity, and it includes the investigation of the stability, the transient characteristics, the comparison of continuous and discontinuous controllers, and reactivity requirements for control rods during large power changes. The method of analysis and an outline of results are given. (auth)

10556 LEAK TESTS ON CALDER-TYPE REACTORS. J. K. Smith (Atomic Energy Authority) and J. Cheetham. J. Brit. Nuclear Energy Conf., 6: 62-9(Jan. 1961).

The operation of the first reactors at Calder Hall revealed a significant leakage of carbon dioxide coolant. Tests have been carried out on subsequent reactors to establish the leakage rate and to trace and minimize this loss of coolant gas. The tests carried out on Calder reactors 3 and 4 and Chapelcross reactors 1 and 2 are discussed. The various methods used to determine the rate and to locate the origin of gas leaks are outlined. A number of conclusions were reached on design aspects, and

several suggestions are made for improving gas tightness of future plants of a similar construction. (auth)

10557 SHIELDING AND SAFETY SYSTEMS IN SHIP REACTORS. (ENGINEERING PROBLEMS IN SHIP REACTORS. III.). A. Mareske (Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Hamburg, Germany). Kerntechnik, 2: 370-3(Nov. 1960). (In German)

In the last part of the article on the engineering problems connected with ship reactors, the requirements of the shield device are first discussed. The safety container is then considered, and the primary and secondary shielding are described. (J.S.R.)

10558 TRAWSFYNYDD. Nuclear Eng., 6: 12-15(Jan. 1961).

A description of the Trawsfynydd Nuclear Power Station is presented. The station shows an increase in over-all efficiency and a reduction in vessel dimensions due to refinement of design detail rather than to the discovery of any radically new principles. The sleeves were eliminated from fuel channels. In the coolant circuit, variable-speed drives for blowers were abandoned in favor of direct-coupled induction motors. Expansion joints were used in the gas ducting. Instead of glazed enclosures and local shielding, complete concrete shielding was used for the boiler house. Aggregate available locally was not of very high density and its use necessitated the provision of thicker shielding. The cylindrical boilogical shield surrounding the reactor was made of concrete with walls 10 ft 6 in. thick up to 43 ft 9 in. level and 10 ft thick above this. Fault conditions analysis is discussed, including a description of faults causing divergence, channel fires, failure of gas circulators, and gross pressure loss. The Trawsfynydd core is composed of 3740 vertical fuel-element channels and another 465 vertical holes which can be used for control rods, etc. The graphite used is in blocks up to 32 in. long and there are over 100,000 primary graphite components in the core. Various types of strain on the graphite blocks are discussed. (M.C.G.)

10559 EARTHQUAKE-RESISTANT CORE FOR TOKAI-MURA. R. W. Bailey and J. L. Head (General Electric Co., Ltd., Erith, Kent, Eng. and Simon-Carves Atomic Energy Group, Erith, Kent, Eng.). Nuclear Eng., 6: 25-7(Jan. 1961).

The development of a graphite core for the Tokai-Mura Power Reactor which would be able to resist the additional loads occurring during an earthquake is discussed. For the core, a seismic coefficient three times that given by the Japanese Building Code was specified. Studies were carried out on compacted and noncompacted core designs in each of which stability was maintained despite shrinkage of the graphite. Vibration, thermal cycling, and strength tests were developed to study core behavior. Three-dimensional models were also used in the studies. (M.C.G.)

10560 EGCR–DESCENDANT OF CALDER HALL. William F. Banks (Allis-Chalmers Mfg. Co., [Milwaukee]). Nuclear Eng., 6: 28-32(Jan. 1961).

The Experimental Gas-cooled Reactor is characterized by the following: helium coolant, ceramic fuel in pressure-tight stainless-steel cladding, heterogeneous graphite core, and on-stream replacement of failed and exhausted fuel elements. The reactor will serve as a power demonstration plant and as a test reactor. The various components, detection of failed elements, decontamination of charging and servicing equipment, and the construction schedule are discussed. (M.C.G.)

10561 CAPITAL-COSTS REDUCED FOR FAST BREEDERS. John G. Yevick and Alfred Amorosi (Atomic Power Development Associates, Inc., Detroit). Nucleonics, 19, No. 2, 64-9(Feb. 1961).

The APDA Plutonium Fueled Fast Breeder Reactor (PFFBR) represents a 50% saving in capital cost over the EFFBR and EBR-II designs fixed in 1955. Technological advances, improved understanding of design requirements, and operation of prototypes and models over the intervening five years resulted in a new fuel material, redesigned auxiliaries, and cheaper shielding. The design improvements involved plant layout, reactor vessel, plug, refueling equipment, sodium pumps, heat exchangers, and steam generator. The 150 Mw(e) PFFBR will operate on recycle plutonium with only depleted uranium makeup. The new shield materials and arrangement allow easier access and cost savings. (T.R.H.)

10562 BRITISH NUCLEAR POWER STATIONS. Rolt Hammond. London, Macdonald & Co., Ltd., 1961. 189p.

This survey of the British nuclear power program includes an outline of the plan for the next 20 years, descriptions of nuclear power stations, discussions of some of the thermonuclear research in progress, and a review of the special problems of nuclear power. The Calder Hall, Hinkley Point, Berkeley, and Hunterston Power Stations are described. Electrical control and switchgear for the reactors are also described. The research going on at the Dounreay Fast Breeder Reactor and at Harwell is reviewed. (M.C.G.)

10563 IMPROVEMENTS IN NUCLEAR POWER PLANTS WORKING WITH A HOMOGENEOUS REACTOR. (to Société Francaise des Constructions Babcock & Wilcox). French Patent 1,203,595. Jan. 20, 1960.

In order to avoid contamination of the turbine by radioactive products in a homogeneous reactor power plant, wherein the liquid fuel circulates through heat exchangers and may there create neutrons by photodisintegration induced by its γ radiation so that these neutrons may induce the formation of radioactive products in the evaporating working fluid, the space for this evaporating liquid is separated into two compartments each heated by the liquid fuel. The steam produced in the first of these compartments is condensed by mixing with the boiler feed water and fed into the second compartment, while the first compartment is fed by the liquid excess of the second compartment; so in the latter, where the steam driving the turbine is formed, a continuous deconcentration of the radioactive contamination takes place. (NPO)

10564 HETEROGENEOUS, HIGH TEMPERATURE POWER REACTOR. (to U. S. Atomic Energy Commission). French Patent 1,223,197. June 15, 1960.

A gas-cooled power reactor comprises an annular graphite core able to turn about its vertical axis. The fuel-element channels cross the core structure radially. The charge or discharge of a fuel element is easily performed by turning the core so that the end of the fuel-element channel in question comes in front of one of several charge openings in the reactor shell. A new element is then pushed from outside into the channel to displace the element already there, which thus falls into the central hole. The coolant gas enters the reactor at the central hole, circulates in the fuel-element channels, and leaves the reactor through conduits that are in connection with an annular space formed between the core and the reactor shell. (NPO)

Research Reactors

10565 (CF-57-1-28) THE HRT REFRIGERATING SYSTEM. M. D. Silverman (Oak Ridge National Lab., Tenn.). Jan. 9, 1957. 10p.

The HRT refrigeration system was designed to use Freon-11 (CCl_3F) as the refrigerant material in the secondary loop. A Van de Graaff irradiation of this material indicated that serious corrosion problems were probable if Freon were used in the proposed metal system. A survey was made of candidate refrigerants, and Amsco 125-82 and triethyl phosphate were selected for irradiation and physical-property determinations. (W.L.H.)

10566 (CF-59-3-67) ESTIMATE OF THE FAST EFFECT IN THE LID TANK SOURCE PLATE. Lawrence Dresner (Oak Ridge National Lab., Tenn.). Mar. 31, 1959. 8p.

An estimate was made of the fast effect in the lid tank source plate. The number of fast fissions per thermal fission is 0.019. (auth)

10567 (CF-59-8-59) SHUT-DOWN COOLING OF ORR. T. E. Cole (Oak Ridge National Lab., Tenn.). Aug. 14, 1959. 20p.

Information is presented that may be used in estimating the magnitude of the shutdown cooling problem in the ORR at various power levels. The information used in the investigation was obtained from other research reactors. (W.L.H.)

10568 (CF-59-9-66) PRELIMINARY STUDY OF INTERMEDIATE-ENERGY RESEARCH REACTORS. J. P. Sanders (Oak Ridge National Lab., Tenn.). Sept. 1, 1959. 8p.

A limited investigation was made of possible reactor configurations that would contain a region having a high intermediate-energy (1 to 10^3 ev) flux relative to the fast and thermal flux. All calculations were performed with a multigroup, multiregion reactor program (GNU-II). Consideration of a single-region, unreflected sphere indicated that the desired flux distribution could not be generated in a region containing fuel because of its resonance absorption. A flux-trap configuration was investigated with a cyclindrical iron core surrounded by a fuel annulus. Calculations indicated that the fast flux would not be depressed significantly in the central region unless the dimensions were large. Consideration was then given to an iron reflector for an infinite slab reactor. Good agreement was obtained between reported experimental and calculated relaxation lengths for the flux at different energies. It was found that the desired flux-energy distribution was approached at a point some 20 to 30 cm into the iron slab from the fuel; however, the magnitude of the flux relative to that in the fuel region was low. (auth)

10569 (CF-59-10-104) TSR-II FLUID FLOW STUDIES. W. R. Gambill (Oak Ridge National Lab., Tenn.). Oct. 21, 1959. 32p.

An investigation of fluid flow in a full-scale quarter-sphere model of the Tower Shielding Reactor-II was conducted to determine the degree of orificing necessary for attainment of a flow rate distribution compatible with the power generation profile. An extreme radial asymmetry of flow rate was observed across the unorificed second-pass flow channels. This condition was largely corrected by the installation of screens over the inlets of certain of the channels when the decision was made not to use screens. The same flow correction was later attained by the use of a perforated plate in the second-pass distribution channel. A determination of friction factor variation with Reynolds number for the particular entrance conditions of the TSR-II second pass revealed a smooth transition between the laminar and turbulent flow regimes. It was consequently decided that no inherent instability would be associated with reactor operation in the transition region. A composite screen for installation beneath the helical tubes above the first-pass inlet was designed. The screen transformed the very peaked velocity profile beneath the tubes to a reasonably flat one. (auth)

10570 (CF-60-11-75) EXPERIMENTAL DETERMINATION OF AN ADEQUATE FISSION CHAMBER LOCATION IN THE ORR POOL. D. P. Roux and A. L. Colomb (Oak Ridge National Lab., Tenn.). Nov. 4, 1960. 13p.

An experiment was performed at the ORR in order to find a good fission chamber location. Two locations on the pool side of the reactor tank were explored with a 1-in.-diameter fission chamber. The thermal-neutron-flux attenuation was found to vary nearly exponentially with distance, and no shadowing effect could be seen during a reactor startup. The fission products high-gamma flux could be discriminated without difficulties. Both positions seem to be adequate to locate a reactor-control fission channel. (auth)

10571 (CF-60-11-76) ANALOG STUDY OF THE REFERENCE DESIGN OF THE GAS-COOLED ORR LOOP NO. 1. S. J. Ball (Oak Ridge National Lab., Tenn.). Nov. 8, 1960. 24p.

A simulation study of the design as of June 1960 of the gas-cooled ORR Loop No. 1 was made using the ORNL analog computer. The proposed method of temperature control is evaluated, and the dynamic behavior of the loop for accidents and component failures is presented in graphical form. (auth)

10572 (CF-61-1-49) SOME HEAT TRANSFER CHARACTERISTICS OF ORR FUEL ELEMENTS. J. F. Wett, Jr. (Oak Ridge National Lab., Tenn.). Jan. 19, 1961. 17p.

Various heat-transfer characteristics are examined, including heat distribution in the reactor, temperature distribution opposite an occlusion or bubble at cladding interfaces, thermal gradients from areas of high to low power generation, and temperature distribution in aluminum-cadmium shim rods. A hot spot-hot channel analysis leading to an expression for an ORR factor related to this parameter was made. (J.R.D.)

10573 (IDO-16633) MATERIALS TESTING REACTOR-ENGINEERING TEST REACTOR TECHNICAL BRANCHES QUARTERLY REPORT [for] JANUARY 1–MARCH 31, 1960. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). 60p. Contract AT(10-1)-205.

The ETR safety channels were further improved by modifications to the redesigned level preamplifiers that increase the damping factor and eliminate tendency of the circuit to ring when a transient signal occurs. Neutron flux integrals and the product of neutron flux times adjoint flux integrals from two-group DMM reactor problems are obtained directly from the IBM-650 by a new program, DMM FAD. Volume-flux-weighted average cross sections can be obtained from a supplemental program to Weil's P_3 program in cylindrical coordinates. Four methods of obtaining the fast neutron group constants for a few-group reactor calculation on aluminum–water cores with the MUFT-III code were investigated. A formalism was developed for identifying neutron flux spectra in terms of three independent parameters: the neutron flux density, the neutron temperature of the Maxwellian component, and the 1/E component of the distribution function at 1 ev. The effective value of the neutron reproduction factor ratio $\eta(U^{233})/\eta(U^{235})$ was found to be 1.106 ± 0.020, based on RMF measurements and MTR cross section values. Measured reaction rates between water vapor and molten Al–23.4 wt.% U alloy show a maximum rate

at 1600°F. Energy-dependent and absolute measurements of eta for U^{233} and Pu^{239} are being pursued. Preliminary total cross section data for Pa^{231} and Pu^{241} from 3 to 20 ev are presented. The advantage gained in lowered backgrounds by use of the new fast chopper rotor with the K-Monel center section is demonstrated by comparison of corresponding transmission data taken with the new and old rotors. In the beryllium gases experiment, an irradiated beryllium specimen yielded 8.7 cc of gas per cc beryllium, which is to be compared with a calculated content of 7.5 cc/cc beryllium. The ratios of the yields of metastable states to ground states induced by irradiations of bare and cadmium-covered samples were found to be the same for Rh^{103} and to differ by a factor of 0.68 ± 0.02 for Ir^{191}. Values of 16 barns for the capture cross section of Sb^{124} and 96.6 ± 6.8 barns for the 2200 m/sec capture cross section of U^{235} were obtained. For Pm^{147} the activation cross section for the production of both isomers of Pm^{148} is 242 barns and the resonance activation integral is 2850 barns. Preliminary values of the Pm^{148} capture cross sections for reactor spectra are 18,000 barns for 42 d Pm^{148} and < 2000 barns for 5.3 d Pm^{148}. In the inelastic scattering of slow neutrons program, data are being obtained on the energy and angular distributions of 0.025 ev neutrons scattered by methane. Parts of the acoustical branches of the dispersion curves for a beryllium single crystal taken for the [001] direction in reciprocal space are presented. Investigation of γ rays in 3.6 hr Y^{92} showed that modifications are needed to results previously reported in the literature. Gamma-ray measurements on Pm^{148} have permitted proposal of a consistent decay scheme for both Pm^{148} and Sm^{148}. A line voltage and noise monitor instrument that records voltage fluctuations, high frequency line transients, and momentary line interruptions was improved by use of transistors in the second model built. A liquid drop counter that delivers automatically to a sample a preselected number of drops of solution was developed and tested. In theoretical studies aimed at interpretation of data being taken at MTR for determination of absolute differential scattering cross sections of hydrocarbon gases, the method of Kreiger and Nelkin was extended and applied to calculations on methane and deuterated methane with good results. Calculations of the cross section for ethane by McMurry's formulation of Zemach and Glauber's method indicate that experiments with neutrons will not reveal the magnitude of the torsional frequency. A method developed for calculating vibration frequencies in paraffins is being applied to propane. Weil's P_3 program for solving the transport equation makes provision for including the third term in the spherical harmonics expansion. Magnitude of the effect of this term on results was studied in calculations on organic reactors and indications are that it can be omitted. In criticality studies an IBM-650 code was developed and applied to problems of fuel storage in the MTR vault and canal. A number of IBM-650 codes were worked out for curve fitting. (For preceding period see IDO-16620.) (auth)

10574 (MMPP-110-2) DEFORMATION OF THE FORD NUCLEAR REACTOR SHIM-SAFETY RODS. C. W. Ricker, W. R. Dunbar, and J. B. Bullock (Michigan. Univ., Ann Arbor. Michigan Memorial-Phoenix Project). Dec. 1960. 25p.

A description is presented of a jamming incident in which a shim-safety rod in the Ford Nuclear Reactor (FNR) jammed in its special fuel element during a routine reactor start-up. Rod deformations are described along with the initial investigations, and a program for further examination to conclusively establish the cause of the incident is outlined. Hypotheses offered for the cause of the incident include existence of mechanical stresses resulting from expansion of wet B_4C powder, internal gas pressure generated by $B^{10}(n,\alpha)Li^7$ reactions, chemical reactions between B_4C or Li^7 and water, and radiolysis of water. (J.R.D.)

10575 (NAA-SR-5499) SAFEGUARDS SUMMARY FOR THE AE-6 REACTOR. G. L. Blackshaw and C. H. Skeen (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [nd]. 170p. Contract AT(11-1)-GEN-8.

A safeguards summary for the AE-6 water boiler reactor was compiled, with the reactor and its physical and geographical surroundings being described in detail. An accident considered to be the maximum likely accident was selected for careful study, leading to the conclusion that operation of the AE-6 reactor presents no unusual hazards to the operating personnel of this reactor nor to the general public. (auth)

10576 (NAA-SR-Memo-5395) OPERATING MANUAL FOR THE AE-6 REACTOR. E. A. Moore, Jr. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 23, 1960. 137p.

An attempt is made to provide a single reference source for material pertinent to the maintenance and operation of the AE-6 Reactor. Descriptions of various components are included, as well as the common operational and maintenance procedures and check lists. Information is given on the subcritical assemblies that may be studied. (W.D.M.)

10577 (NP-9360) HAZARDS SUMMARY FOR THE NUCLEAR RESEARCH REACTOR LOCATED AT THE CURTISS-WRIGHT NUCLEAR RESEARCH LABORATORY OF THE PENNSYLVANIA STATE UNIVERSITY. Forrest J. Remick and Nunzio J. Palladino (Pennsylvania State Univ., Quehanna. Curtiss-Wright Nuclear Research Lab. and Pennsylvania State Univ., University Park). September 1960. 176p. (PSR-315-496012).

With this is bound: Appendix II. METEOROLOGICAL APPRAISAL OF THE QUEHANNA, PA. SITE. D. H. Pack (Weather Bureau. Office of Meteorological Research, Washington, D. C.). May 3, 1956.

The 4-Mw swimming pool reactor located at Quehanna, Pennsylvania, is to be utilized for shielding studies, reactor component and instrument development, radiation damage studies, neutron physics studies, isotope production, activation analysis, and training. Supporting facilities, site, operational procedures, and safety devices are described in detail. The effects of human and instrument errors, particularly in combination with the failure of safety devices, are examined. The possible consequences of the release of radioactivity to the general environment are considered. (W.D.M.)

10578 (ORNL-3028) FAST-FLUX MEASUREMENTS IN THE ORR CORE. P. Dragoumis, J. R. Weir, Jr., and G. W. Leddicotte (Oak Ridge National Lab., Tenn.). Feb. 7, 1961. 45p. Contract W-7405-eng-26.

The necessity for measuring the fast-neutron flux in beryllium irradiation studies led to mapping the fast flux in two positions of the ORR. The axial neutron flux distributions for thermal, 0.70 Mev, and 2.9 Mev, were measured using Co^{59}, Np^{237}, and S^{32}, respectively. The methods used in the manufacture of the flux monitors and the techniques used in making the measurements are described. Axial-flux peaking in the ORR core occurs at about 3 in. below the reactor midplane. In the B-2 core position, the thermal-flux peak is 9.5×10^{13} neutrons/cm^2 · sec when the reactor

is at 20 Mw. The maximum fast-flux values in B-2 are 8×10^{13} neutrons/cm^2 · sec (greater than 0.7 Mev) and 1.8×10^{13} neutrons/cm^2 · sec (greater than 2.9 Mev). In the B-8 position, maximum flux values were not measured. Observed fluxes were 1.4×10^{14} neutrons/cm^2 · sec (greater than 0.7 Mev) and 2×10^{13} neutrons/cm^2 · sec (greater than 2.9 Mev). (auth)

10579 MEASUREMENT, CONTROL, AND SAFETY CHANNELS OF THE FR-2 REACTOR. H. Liesegang (Siemens & Halske Aktiengesellschaft, Karlsruhe, Germany). Atomwirtschaft, 5: 575-82(Dec. 1960). (In German)

The nuclear measurement channels for the core of the Karlsruhe FR-2 Reactor do not function independently but form a close meshed system. On safety grounds, they are, with few exceptions, built on the 2-out-of-3 principle. The design of the individual channels and the peculiarities of the apparatus for the nuclear instrumentation are described (auth)

10580 TRIGGER METHOD, AN IRRADIATION METHOD AT THE MUNICH RESEARCH REACTOR. M. Pollermann (Technische Hochschule, Munich, Germany). Kerntechnik, 2: 349-54(Nov. 1960). (In German)

Devices and engineering execution of an irradiation method are described. With the method samples can be irradiated at high doses in the Munich Research Reactor and can be safely handled. (tr-auth)

10581 LOCAL FLUX DISTRIBUTIONS IN ORR FUEL ELEMENTS. A. L. Colomb and A. F. Wett, Jr. (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng., 9: 96-8(Jan. 1961).

A detailed study was made of the thermal neutron flux distribution in the Oak Ridge Research Reactor. Results indicated that rather large flux gradients exist radially across the MTR type fuel element employed in this reactor and that these gradients are strongly dependent on the fuel concentration in the element being investigated as well as that of the adjacent elements. The technique used to measure flux consists of measuring the induced activity in a 20-mil cobalt wire. It was concluded that when a heavily burned element is placed next to a new element, the flux will peak in the burned element and show a depression in the new element. The placing of large water gaps such as that which exists between the fuel and the cadmium sections in the shim rod appeared to cause large peaks in the adjacent elements. (M.C.G.)

WASTE DISPOSAL AND PROCESSING

10582 (ANL-6199(p.133-46)) COMPARISONS OF CALCULATED AND OBSERVED PLUME RISE. H. Moses, E. J. Kaplin, and G. H. Strom.

There are at least six theoretical or empirical formulas that may be used in calculating the height to which the plume from a stack will rise in the atmosphere and the resulting particle concentrations at ground level. A comparison is made of the formulas of Sutton, Holland, Davidson, and Bryant. (C.H.)

10583 (WIN-119) QUARTERLY REPORT [ON WASTE PROCESSING], JULY 31, 1960–SEPTEMBER 30, 1960. (National Lead Co., Inc. Winchester Lab., Winchester, Mass.). Dec. 29, 1960. Contract AT(49-6)-924. 34p.

Work done in analytical development, decontamination of mill effluents, and evaluation of radiological hazards related to the processing of uranium ores is summarized. Data are presented on the decontamination of mill effluents by barium chloride addition, as well as preliminary information of activity levels in mill dusts. Leaching studies on mill tailings are reported. Some information is given on sampling of soils adjacent to processing mills and mill tailings. (For preceding period see WIN-117.) (auth)

10584 (NP-tr-553) THE EFFECT OF SYNTHETIC DETERGENTS AND COMPLEXING AGENTS ON THE DECONTAMINATION OF RADIOACTIVE EFFLUENTS BY MEANS OF THE CHEMICAL PRECIPITATION METHOD. S. Krawczynski. Translated by F. Hudswell (U.K.A.E.A. Atomic Energy Research Establishment) from Atompraxis, 6: 320-2(1960). 12p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 23835.

10585 SOME ASPECTS OF MEANS OF LOCATING RADIOISOTOPES AND THE PROBLEM OF SAFE STORAGE. P. V. Zimakov and V. V. Kulichenko. Atomnaya Energ. 10: 58-63(Jan. 1961). (In Russian)

Safe disposal of radioactive fission fragments is achieved by consolidating liquid waste into solids. Fixation in glass shows certain advantages. A physico-chemical analysis of the behavior of fragments fixed in glass is discussed. Chemical fractionation and x-ray-structural analyses indicate certain heterogeneous structures in the melted material and irregular behavior during leaching. It is shown that ionizing emissions increase crystalline fracture in the examined preparations. (tr-auth)

10586 TREATMENT AND DISPOSAL OF RADIOACTIVE WASTES. R. H. Burns (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Chem. & Process Eng., 42: 15-19(Jan. 1961).

In Great Britain the greatest amount of radioactive waste arises from work carried out by the Atomic Energy Authority. These wastes vary considerably, ranging from highly radioactive liquids, resulting from the processing of spent nuclear fuel, to the effluents from the research centers and isotope production units. During the operation of a nuclear reactor a complex mixture of radioactive elements is formed in the fuel, collectively called fission products. The exact composition of the mixture depends on the type of fuel used and the rate of burn-up in the reactor. There are normally over 30 elements so produced ranging from Zn^{72} to Dy^{61}. Many of the fission products have short half lives and decay very quickly so they present no major problem. Wastes containing fission products possessing long half lives and those which have the lowest allowable concentrations in the human body must be treated and disposed of without contaminating the environment. Procedures for the treatment and disposal of radioactive wastes are reviewed. General methods of concentration, containment, and dispersal are discussed. Factors involved in decontamination of wastes, ion exchange processes, chemical precipitation, and direct dispersal methods are discussed in detail. Flow diagrams are included for a typical method which incorporates all the commonly employed processes for the treatment of radioactive liquids and a process for recycling liquid radioactive wastes. Methods for conversion of liquid wastes into solid form and for the disposal of solid wastes are discussed. (C.H.)

10587 THE ELIMINATION OF RADIOACTIVE WASTE. F. Duhamel (Commissariat à l'Energie Atomique, Saclay, France). Energie nucléaire, 2: 152-9(May-June, 1960). (CEA-1738). (In French)

The topics presented at this lecture are the production

of the waste; the gaseous products; the strong, intermediate, and weak reaioactive waste; the disposal of liquid residues; and the storing of solid products. This lecture had the great merit of forming an international working basis for a domain in which cooperation is possible. The majority of the important problems were at least mentioned. (T.R.H.)

10588 HANDLING OF LIQUID WASTES IN THE REGION OF THE KARLSRUHE ATOMIC CENTER. Stefan Krawczynski. Gas- u Wasserfach, 101: No. 36-38, 9p. (1960). (KFK-36). (In German)

The various types of waste water from the Karlsruhe Atomic Research Center are outlined, and the treatment of the radioactive wastes is described. Precipitation, ion exchange, and evaporation processes are used. The precipitation steps are removal of cesium using Ca_2FeCN_6 and $CuSO_4$, removal of sulfur as $BaSO_4$, decarbonization by $Ca(OH)_2$, electro-ionic precipitation on metal chips in a special percolator, and precipitation by H_3PO_4 at the neutral point, followed by filtration. The apparatus and flowsheets for the precipitation process, as well as the apparatus for the ion exchange and evaporation steps, are described. (T.R.H.)

10589 SORPTION OF CESIUM BY CONASAUGA SHALE. D. G. Jacobs (Oak Ridge National Lab., Tenn.). Health Phys., 4: 157-63(Dec. 1960).

Disposal of intermediate-level wastes at ORNL involves the discharge of the waste into a series of three 1 million-gal pits excavated in a Conasauga shale formation. The activity of the waste is about 1.9×10^6 dis/min per ml, which is too great for direct release to the uncontrolled environment. The solution is essentially basic sodium nitrate with Cs^{137} contributing the majority of the activity. Conasauga shale has been found to be effective for removal of cesium from the waste stream. The partial cesium capacity of the shale was found to be dependent on the nature and concentration of the major stable cations present in the waste. The capacity of the shale for fixation of cesium greatly exceeds the capacity of the shale for sorption of cesium from the waste stream; thus the cesium retained from the waste stream would be very difficult to remove from the formation by percolating ground water. Because fixation sites incorporate charge deficiency with structural parameters, removal of cesium from the shale is increased by increasing the concentration of cations in the leaching solution. (auth)

10590 NATURE AND CONTROL OF RADIOACTIVE WASTES IN PENNSYLVANIA WATERS. Walter A. Lyon (Pennsylvania Dept. of Health, Harrisburg). J. Am. Water Works Assoc., 53: 89-97 (Jan. 1961).

The Pennsylvania Department of Health is presently studying the nature of radioactivity in waters in the state and is attempting to control the radioactivity that may be discharged into these waters. During the summer of 1959, samples were taken from 16 typical Pennsylvania water supply facilities in order to determine the levels of radioactivity found in raw and finished waters. Some water samples were also taken from impounded sources, streamside sources, and ground-water sources. The greatest amount of radioactivity found in the streams was the result of fall-out from nuclear tests. Radioactivity from fall-out is associated with both dissolved and suspended solids. Sedimentation, coagulation, and filtration were found to be effective in the removal of suspended solids, but not radioactivity associated with dissolved solids. One exception was found in the lime softening of water, which removed a high percentage of Sr^{90} contamination. The two most effective means of removing radioactivity from water were found to be ion exchange and distillation. With these two methods, 99.99% of the radioactivity can be removed. (C.H.)

10591 PROCESS AND EQUIPMENT FOR RENDERING RADIOACTIVE WASTES INNOCUOUS. R. Alberti. French Patent 1,214,570. Nov. 9, 1959.

Liquid wastes are rendered innocuous by absorption in a powderous or granulated material which entirely or partly consists of a substance with a high absorption power toward radiation, such as heavy metals and their compounds. An absorbent containing at least 50% barite is preferred; additions can consist of ion exchangers, sawdust, vermiculite, cement, sand, peat, etc. The absorbent is used as a filter or cleaning agent or for sprinkling purposes; after use it is calcined or made to harden. (NPO)